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• FIELD CROP GUIDE

FOR THE
ATLANTIC PROVINCES



Prepared by the
ADVISORY COMMITTEES ON
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AND FORAGE CROPS.

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The FIELD CROP GUIDE contains the pooled findings and recommendations for Atlantic Agriculture. All sections were prepared by representatives of the Advisory Committees and Subcommittees of the Atlantic Provinces Agricultural Services Co-ordinating Committee. The New Brunswick Department of the Environment provided information on Pesticides.

Since publication is at intervals of several years, specific recommendations will change before the next issue appears. In view of this, care should be taken to check on approved recommendations from time to time.

Specific variety and pesticide recommendations are found in Publication 100A — the annual supplement to this book.

More detailed and, at times, more current, agricultural production and management information is contained in publications available from the nearest Agricultural Representative.

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(see page 45) _____

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INTRODUCTION

The climate of any farm will determine, in large part, the success or failure of crops grown. Selection of crop, cultivar, or hybrid, time of planting and rate of development are all dependent on the weather. Although many important daily decisions are made based upon the two to five day weather outlook, there are some major longer-term decisions projected over five years, ten years and much longer that require the best available information as to the type of growing conditions a farmer will expect to have on his land.

Long-term weather stations in the Atlantic Region help determine the amount and range of rainfall and temperatures an area usually receives. This can be combined with knowledge of the terrain and marine influences to draw maps reflecting the average climate of the region. The accompanying maps on precipitation, frost-free periods and growing degree days were constructed from 233 climate stations with climate data available for the 1951-1980 period. This rainfall and temperature data can be a useful guide in determining if an area or farm has enough moisture, enough heat or an adequate number of frost-free days to grow a specific crop. Time of planting, dates of fertilizer application, disease and pest development rates, cutting and harvesting schedules and several other management decisions require long-term estimates of the climate of the area.

The climate of the region varies significantly as the map lines indicate. Farm level climate can vary significantly depending upon the field location. Through proper site selection, variety selection and long-term planning, the climate of the farm can be utilized to improve production and save dollars.

CLIMATIC NORMALS

A long period of weather observations is necessary to understand the expected variety of weather on the average. The term "Climate Normals" is used to describe the average data for a 30-year period.

Climatic normals represent the average of widely varied yearly values which occurred over the 30-year period. When evaluating crop performance in any given year, compare that year's weather to the climatic normals to judge whether the season and crop performance were typical.

(i) May-September Precipitation

The precipitation normals are based upon daily observations of rainfall from May 1st to September 30th inclusive from the 1951-1980 time period. In the Atlantic region, the precipitation varies from 400 mm. to 600 mm. during the growing season.

(ii) Growing Degree-Days (Heat Units)

Temperature affects plant processes mainly by controlling the rate of growth. There are certain minimum temperatures below which plants do not grow. For perennial forage production, a threshold temperature of 5°C is most valid. The value of 5°C is used because at that average temperature, the daily maximum is about 10°C and the minimum is 0°C. Most plants do not grow when minimum temperatures are below 0°C. The growing season for forage production is defined as the number of days between the date in the spring when the average temperature rises above 5°C and the date in the fall when the average temperature drops to 5°C.

The concept of growing degree-days, or heat units, assumes that plant growth is related directly to the average

temperature. To compute degree-days for a particular day, calculate the average of the maximum and minimum temperature for the day, then subtract the base temperature from the average temperature.

Example:

Maximum Temperature = 24°C

Minimum Temperature = 16°C

Average Temperature =

$$24 + 16 = 40 / 2 = 20^{\circ}\text{C}$$

Degree-days above 5°C = $20 - 5 = 15$

If the daily average temperature is below the base temperature, the degree-day value is zero. Negative values are not used because the crop is not set back. When using degree-days, be sure to know what base temperature, and temperature scale have been used. Corn heat units are widely used for corn hybrid maturity rating. They differ from degree-days described above in that the maximum and the minimum temperature are used separately to assess the contribution to corn development. Higher maximum temperatures are preferred and are given more weight than cooler minimums, reflecting the heat loving nature of the crop.

Degree-day information is used to indicate heat available in an area for crop production. Select crops or varieties with a heat requirement matched to the location.

(iii) Frost-Free Days

The growing season for frost sensitive crops is determined by the last spring frost and first fall frost. Although coastal locations have long frost-free periods, they do not have the high temperatures required for the rapid growth and maturity of warm season crops.

Frost normals can vary significantly within short distances due to the effect of steep terrain or large bodies of water (see section on Farm Level Climate). It is important to have a long period of record if possible when mapping this factor. The normal frost-free periods range from less than 70 days in central Newfoundland to 170 days in some Maritime coastal zones.

FARM LEVEL CLIMATE

(i) Introduction

The climate at the farm level can be different than the climate of the surrounding area. Local features interact to produce a climate unique to the location. Knowledge of these factors provides a better understanding of what to expect on your farm in the future. The factors that influence the climate at the farm level are:

- topography
- large water bodies,
- slope,
- aspect,
- wind, and
- elevation.

(ii) Topography

Topography has a marked effect on the incidence of frost. After sunset, the ground cools rapidly and its temperature soon falls below that of air in contact with it. The surface layer of air becomes cooler and heavier. Over sloping ground, this cooled surface air tends to drain to lower levels and to collect in depressions or hollows. In a frost hollow, drainage of cold air into the depression results in frosts much later in

the spring and earlier in the autumn than at surrounding locations. Hillside locations will, on the average, tend to have longer frost-free periods than neighbouring stations on lower ground or in a valley.

Night winds influence temperature differences between hillsides and valleys on clear nights. The best conditions for cold air drainage are found when there is no general air movement. Even a light wind will serve to mix the relatively warm air above with the thin layer of surface air which has cooled through contact with the ground. Moderate winds will prevent differences in temperature between hillsides and valleys.

(iii) Slope and Aspect

Slope plays a major role in farm level climate. Valley bottoms experience colder nighttime temperatures and usually warmer daytime maximums than either midslopes or hilltops. The total heat units over an entire growing season are usually highest on midslopes, less on hilltops and lowest in valley bottoms. This order is much more pronounced when heat units are accumulated between frost dates. Cold air running down the slopes and pooling in valley bottoms causes later spring and earlier fall frost dates. Hilltops usually have a shorter frost-free period than midslopes because of greater exposure to radiative loss to the atmosphere at night. Exposed hilltops have slightly cooler maximum temperatures than midslopes. In winter, midslopes accumulate more snow than hilltops, particularly on the lee side of the prevailing winds. The influence of aspect can change these relationships.

Aspect, or orientation to the direction of the sun, has two roles in crop production. In winter, south facing slopes produce warmer conditions that may result in harmful freezing and thawing cycles. Snow melt accounts for less depth and denser snow packs on south slopes. This results in a decrease in the protective value of the snow which may be important to overwintering perennial crops. In contrast, the growing season conditions are more favourable on south slopes. Warm south and west facing slopes provide more heat units and higher soil temperatures early in the season. Spring soil moisture conditions are generally wet, depending upon soil type. In this instance, south slopes have higher evaporative losses and the field trafficability is earlier as a result.

(iv) Elevation

Elevation has the most influence on precipitation totals and heat unit accumulation. Generally, higher elevations have lower heat units. Precipitation increases with elevation because warm moist air masses are forced upwards by rising land, the air mass cools and the moisture falls out as rain or snow. The proportion of precipitation that falls as snow increases with higher elevation.

(v) Marine Influences

Bodies of water exert a modifying influence on the climate of surrounding localities. Water bodies cool the local climate in summer and warm it in winter. This effect is most pronounced near the coast, but may extend inland several kilometers depending on elevation, topography and prevailing winds.

Water bodies may also extend the frost-free period. Near the ocean at night, land breeze circulations draw cool air away from the land areas. Inland, large lakes and rivers heat the air which drains at night to valley floors. Lakes and rivers

also yield large amounts of moisture to the air. When this air cools, fog forms. All of these processes inhibit the formation of frost and extend the frost-free season.

(vi) Wind

Exposure to high winds is usually detrimental to crop production, and many studies indicate better yields in protected or sheltered areas. Two suggested reasons for this are desiccation of plants from high evapotranspiration losses and physical damage to plants directly from the wind. The establishment of some barrier to the wind on the prevailing wind side, may be required to improve the situation. If additional winter snow cover is desirable, wind breaks will increase this cover. In Atlantic Canada, summer winds are usually from the south and southwest while winter winds are from the north and northeast.

AGROCLIMATIC MAPS

The prevailing wind direction and the relationship of land to water is a major factor determining climatic differences within the region. The southern coasts of New Brunswick, Nova Scotia, and Newfoundland have the highest annual precipitation in Atlantic Canada due to southeasterly storm winds blowing moisture-laden air onshore. In contrast, the Northumberland coasts of New Brunswick and Nova Scotia, all of Prince Edward Island, and northern Newfoundland are in a "rain shadow". This means that southeasterly storm winds have already dropped most of their precipitation by the time they reach these areas and precipitation amounts are reduced.

The distribution of rainfall in the Maritimes is shown in Map 1 for a period roughly corresponding to the growing season. It is important for agricultural crops to have sufficient rain, evenly distributed over the growing season to meet crop water requirements. Seasonal precipitation at Sydney and Yarmouth exceeds potential evapotranspiration so they are unlikely to have crop water deficits. Parts of the eastern shore of New Brunswick and an area around Woodstock experience small deficits in July and August on a regular basis while parts of the Annapolis Valley and the North Shore of Nova Scotia, depending on soil type, may have soil moisture deficits in years with below normal rainfall.

In Newfoundland (see Map 1A), the maximum rainfall occurs along the south coast and falls off rapidly inland. The Long Range Mountains receive fairly high rainfall.

The growing season for frost sensitive crops is determined by the last spring frost and first fall frost. The frost-free period varies a great deal depending upon latitude, elevation, topography, and proximity to large water bodies. Although coastal locations have long frost-free periods, they do not have the high temperatures required for the rapid growth and maturity of warm season crops.

In Map 2, the longest frost-free periods are along the southwest coasts of New Brunswick, Nova Scotia and Prince Edward Island. The frost-free period decreases rapidly with distance away from the moderating influence of the ocean. The coastal area along the Northumberland Strait has a frost-free period of about 130 days very near the water. Inland areas and the higher elevations have the shortest frost-free periods.

The longest frost-free period indicated in Map 2A is along the south coast from Burgeo to Cape Ray. The next longest frost-free period is along the south, west and east coasts. Inland areas and the eastern part of the Northern Peninsula

have the shortest frost-free period. The interior of the Province has a frost-free period of only 70 days.

The largest heat unit totals in the Maritimes are found in the Annapolis Valley of Nova Scotia, the Grand Lake area of New Brunswick, and the coastal area along the Northumberland Strait. (See Map 3.) Cold Atlantic waters reduce degree-day totals along the south and eastern shore of Nova Scotia and along the Bay of Fundy. This influence decreases with distance inland. The warm waters of the Northumberland Strait keep the adjacent Coastal areas warm.

The northeast part of Newfoundland, including the northern part of the Avalon Peninsula, has the most heat units in the Province. (See Map 3A.) This area is sheltered from the prevailing southwesterly winds. A narrow coastal strip from Corner Brook to Stephenville also has high heat unit totals, in this case due to the influence of the warm waters of the Gulf of St. Lawrence. The high evaluation areas of the Long Range Mountains have the lowest heat unit totals. Most coastal areas have low heat unit totals.

PUBLICATIONS WHICH PROVIDE MORE CLIMATIC INFORMATION

"The Climate for Agriculture in Atlantic Canada", prepared by Atlantic Committee on Agrometeorology (A.C.A.)

"Spring Field Work days in the Atlantic Provinces", prepared by A.C.A.

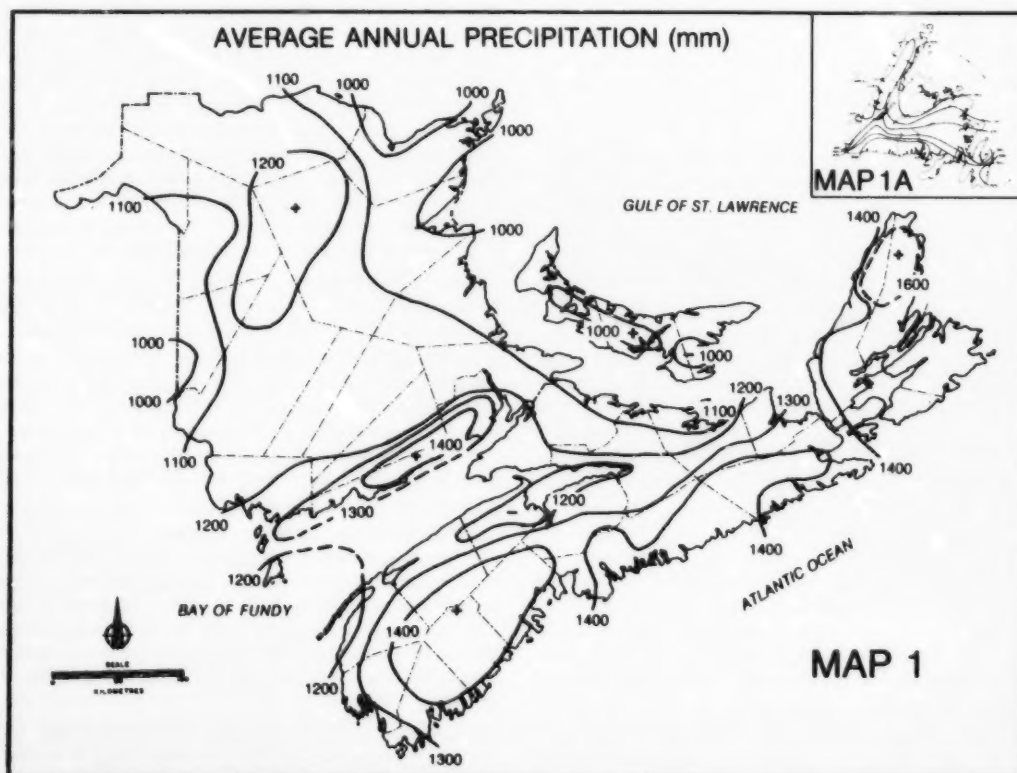
"Fall Field Work days in Canada", prepared by Agriculture Canada.

"Weather Risks for Harvesting Hay", prepared by Agriculture Canada.

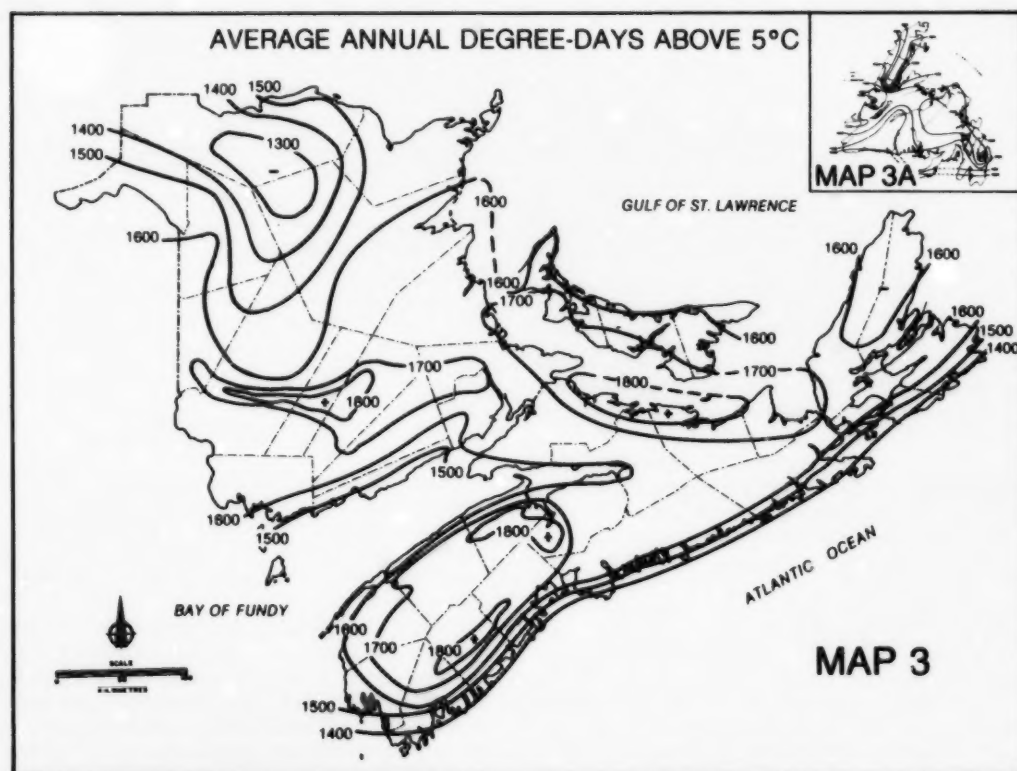
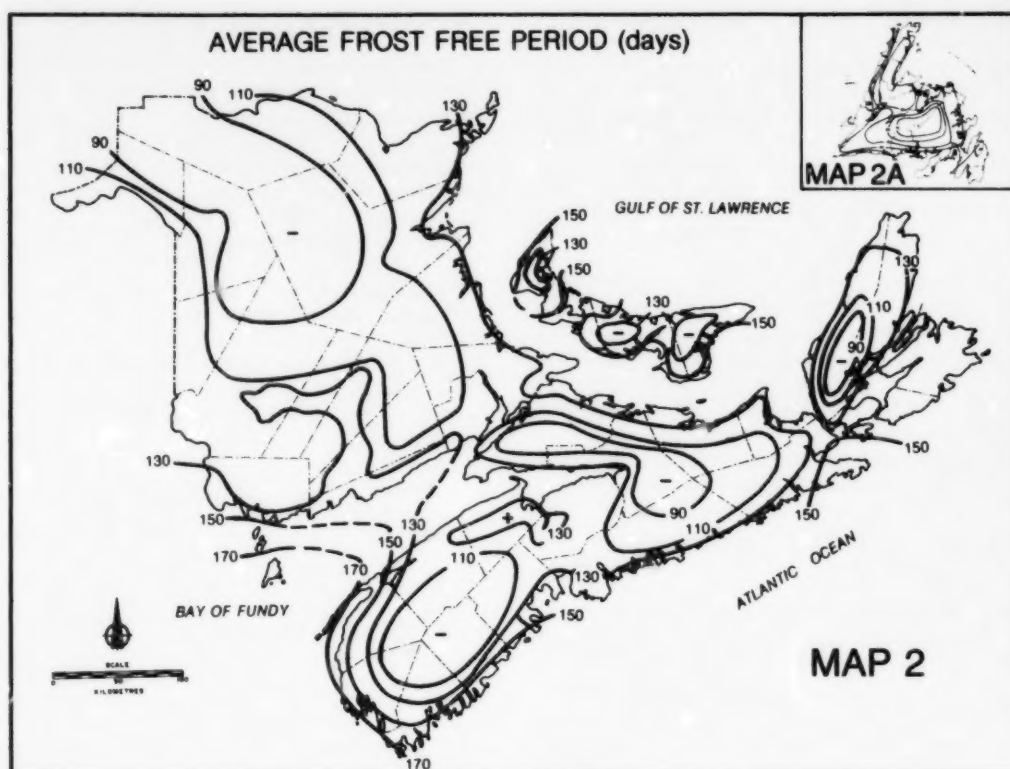
"Probability of Freezing Temperatures in the Spring and Fall in the Atlantic Region", Publication 1565, 1975, Agriculture Canada.

"Growing Degree — Days and Crop Production in Canada", Publication 1635, 1977, Agriculture Canada.

To obtain these publications, or get more information on a climate topic, contact your Provincial Climatologist.



Map 1 and Map 1A. Average May-September precipitation (mm).



Map 3 and Map 3A. Average annual degree days (heat units) above 5°C.

FORAGE PRODUCTION

A forage program must supply high quality feed on a year round basis. Although there is a trend to feeding conserved feed all year, pasture and zero-graze forage are still major crops. No single forage species or mixture will supply the total forage requirement of a livestock farm. The crop grown and storage method is unique to each farm since the choice is based on capital, equipment, land, labour, time of year forage is required, size of operation, type of livestock, personal likes and dislikes. On most farms, the forage program will use several perennial and annual species as hay or haylage, pasture and zero-graze.

Production of good quality forages requires the forage crop be managed as intensively as other high yielding crops. Proper management of forages includes variety selection, fertilizing, pest control, cutting frequency, and fall management of the forage.

Good forage management must be based on the climate, soils, and end use of the forage for each farm.

FIG 1 TOTAL FORAGE PROGRAM FOR PASTURE AND STORED FEED



A program of annual and perennial forages as pasture and stored feed provides good quality forage year round.

CHOOSING A MIXTURE

A good forage program begins with selection of the proper legume and grasses to suit conditions under which the mixture will be grown. Simple mixtures using one legume and one or two grasses are recommended as they are more productive than more complex mixtures. In a complex mixture, the competitive strength of the species is often not related to the forage yield. Strong competition from a low-yielding species will depress the total yield of the stand. Use of more than three species in a mixture will depress yield, even if the species are matched for competitive ability. Pure seedings of a legume or grass are recommended only when field conditions are well suited for the species and the farmer has experience growing the crop.

Choose the legume first. Legumes are beneficial as they contain approximately double the protein of grasses and they improve the soil by fixing nitrogen. Including legumes in the rotation makes this fixed nitrogen available to subsequent crops as well as improving soil structure and increasing organic matter. The legume chosen is determined by the drainage, winter hardiness, intended use, and required duration of stand required. Fertility and pH can be improved to suit the species. Choose the grass to complement the legume from the list of recommended mixtures. Choose specific varieties for the mixture on the basis of heading or flowering date. Legumes should reach first flower when the grass starts to head to ensure maximum yield and quality at harvest (see publication 100A). Legumes in pure stand or mixtures must always be inoculated with the proper species of bacteria.

TIME OF SEEDING

Perennial forage plants must develop sufficient size and root reserves to survive winter temperatures and regrow the following spring.

Spring seeded forages will be large enough to overwinter well and provide 2 to 3 t/ha of dry matter the seeding year. Fall seeding of legumes is not recommended.

SEEDBED PREPARATION

Small seeded legumes and grasses require a fine, firm seedbed in order to get uniform planting depth and germination. Overworking the soil or use of large tillage equipment may result in a very loose seedbed that needs to be firmed with a cultipacker or roller before seeding. Working the soils too early, when the soil is too wet, can lead to crusting and waterlogging which causes poor emergence of legumes.

SEEDING METHOD

The small forage seeds should be distributed uniformly and covered with 1 cm of soil. If the soil is extremely dry, a slightly deeper placement into moist soil may be beneficial. Either a drill or cultipacker seeder may be used. Cultipacker seeders place the seed uniformly in the upper 1 cm of soil and firm the seedbed immediately after planting. Most drill seeders allow the placement of fertilizer in bands below the seed. This is beneficial as seedlings require phosphorous. Seed tubes can be attached to the drill to place the seed directly over the band of fertilizer for maximum benefit.

INOCULATION OF LEGUMES

Legume seed must be inoculated with the proper *Rhizobium* inoculum before planting. The inoculum contains bacteria which form nodules on the roots of legumes and fix nitrogen from air. The correct inoculant must be chosen for each legume. Packets of commercially available inoculant contain live bacteria and should be stored in a cool dark place.

Inoculant should be applied to the seed just prior to seeding. Using a small amount of water or a sticking agent (1 part corn syrup or molasses to 3 parts water) ensures that the inoculant will adhere to the seed. Thorough mixing of the seed and inoculant is necessary. Once seed is inoculated seed should not be exposed to high temperatures. Seed that has been inoculated and stored should be re-inoculated to ensure viable bacteria are on each seed at planting.

COATED SEED

Coatings used on forage seeds contain various combinations of inoculating bacteria, lime, nutrients, and bonding agents. Coatings are intended to improve emergence and establishment of forage seed. Limited research in the region has shown that stands grown from coated seed have no advantage compared to uncoated seed.

Since coated seeds are larger than uncoated seed, a kilogram of coated seed contains fewer seeds than an equal weight of uncoated seed. Generally coated legume seed has 30% fewer seeds than bare seed while grasses have 50% fewer seeds. To plant the recommended rate of seed the rate on the seeder must be increased to allow for the decreased seed per kilogram. Some limited research indicates seeding rates can be reduced with coated seed.

Coated seed is a good method of inoculating legume seed. Carry-over seed should be re-inoculated to ensure the presence of live bacteria in the year of seeding.

DIRECT SEEDING

New forage seedings can be made without a companion or cover crop. Direct seeded forage will normally yield one cut the first year although it will be only 50% of a regular production year. In good years, alfalfa planted in early May can be harvested in July, and again before the recommended last date of cut (see Figure 1).

Adequate fertility, especially phosphorous, is important to direct seeded stands. Using a seed drill to band forage seed over a fertilizer containing phosphates aids seedling growth.

Weeds must be controlled with herbicides or timely mowing to obtain good forage yields in the seeding year. Herbicides are available for grass and broadleaf weeds, but careful planning is required to get the herbicide applied at the proper time.

Fig. 2 Forage quality of perennial species under good management.

	P	G	VG	E
Alfalfa			▲	
Clover - Red			▲	
- White			▲	
- Ladino			▲	▲
- Alsike			▲	
Birdsfoot Trefoil			▲	
Timothy		▲		
Bromegrass		▲		
Orchardgrass		▲		
Reed Canary	▲	▲*		
Fescue - Tall	▲	-▲	-▲	-▲*
- Meadow			▲	
Perennial Ryegrass		▲	▲	
Redtop		▲		
Bluegrass				▲

*forage quality is very dependent on management

UNDERSEEDING/COVER CROPS/ COMPANION CROPS

There are several advantages to underseeding:

- erosion control
- grain and straw production
- weed growth is slowed
- cereal may be used for forage

Problems occur when cereals compete with forage for sunlight, nutrients, and water. If the cereal lodges, cereal yield and forage persistence will be decreased. The competitive effect of the cereal can be reduced by removing the cereal as green chop or silage when it reaches the late dough stage.

Competition from the cereal crop can be reduced by plugging every other run in the drill. This seeds the cereal in 35 cm rows and reduces the seeding rate to 50 to 70 kg/ha.

REDUCED TILLAGE RENOVATION

Sod seeding is a method of renovating pastures and unproductive hay fields where seed is incorporated into existing sod with a minimum of cultivation. Various machines have been developed in recent years for sod seeding. These sod seeders till a furrow and place the seeds in this furrow. They may also cover the seeds, press the soil over the seeds and spray a band of herbicide over the seeded furrow. A good soil-seed contact is essential for germination.

Herbicides are available that suppress existing vegetation until new seedlings are hardy enough to compete. They may be applied in 10 cm bands or as a blanket cover. The utilization of herbicides is not essential in all sod seeding situations and depends on the seeded species, type of sward, time of seeding and the expected results.

BROADCAST SEEDING

On sparse open swards, fertilizer, lime and seed may be spread directly on the surface early in the spring. On dense sod where the sward consists of undesirable grasses or weeds, heavy grazing or the use of herbicides prior to renovation are recommended. The pasture should not be grazed until the new seedlings are well established.

FERTILIZERS FOR FORAGE

General

Forages require large amounts of nutrients to produce a high yielding crop with excellent protein content.

Fertilizer rates and lime recommended from soil tests are chosen to produce highest economic yields when accompanied by good management. A soil test should be taken every two to three years to maintain a productive forage stand. If the stand is 60% or greater in legumes, a boron test should be requested.

Fertilizer cost is reduced and yields increased by liming the soil. Research shows that forage yields are almost doubled when equivalent fertilizer is applied to a soil at a pH of 6.2, compared to an acid soil with a pH of 5.4.

For maximum yields lime or annual fertilization cannot be omitted.

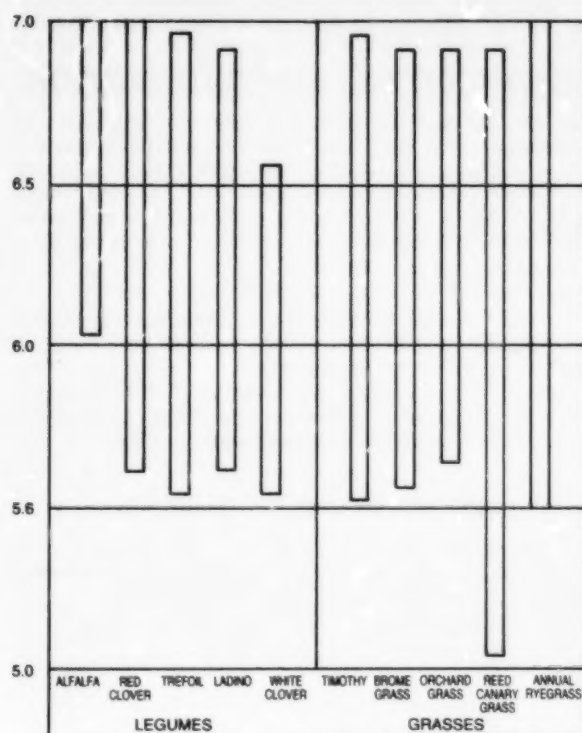
FERTILIZING IN THE SEEDING YEAR

Always apply lime and fertilizer based on a soil test.

Limestone should be applied the fall prior to seeding and worked into the soil in quantities sufficient to raise the pH to 6.4. Choose dolomitic limestone if your soil requires magnesium.

Phosphorus is very important to ensure good root development and seedling establishment. If a soil test indicates soil to be low in phosphorus, greatest response to phosphorus occurs when phosphorus is banded 2 cm below the seed as applied by a drill seeder.

Fig. 3 RECOMMENDED pH FOR FORAGE CROPS.



Nitrogen is required by all forage seedlings. Legumes need nitrogen to promote growth until they become nodulated and can fix their own nitrogen. Excess nitrogen applied in the fall will promote winter injury and will be lost due to leaching.

Potassium should be available to plants in the fall to promote good root development, storage of food reserves for increased spring yields and development of cold hardiness to promote winter survival. Plants use more potassium than any other element.

Boron should be applied to legumes in the seeding year at soil test recommended rates. Excess applications may retard or even kill the forage seedlings. A soil test for boron on alfalfa should be taken every two to three years.

Manure is an excellent source of organic matter and micronutrients. Manures are a good source of nitrogen (see Figure 4). Excessive rates of manure will promote grass at the expense of legumes in a stand.

FERTILIZING ESTABLISHED STANDS

Forage stands lacking adequate fertilization will become unproductive, thin out rapidly and revert back to less productive native swards. Following a balanced fertilization program (see Figure 3) will help ensure longevity of seeded species. To maintain established forage stands for hay and silage:

(1) Fertilize annually and generously with *potassium*, an essential nutrient in maintaining all forage stands.

FIG.4

FERTILIZATION IN THE SEEDING YEAR

Recommended Practice	Kg of Nutrients per hectare			Example Analysis	Rate ¹ (kg/ha)
	N	P ₂ O ₅	K ₂ O		
Band seeding (Seed planted in rows; fertilizer drilled 3-5 cm below seed)					
Broadcast and work in before seeding on infrequently limed and fertilized soils only	15	50	50	5-20-20	250
Band at seeding + Boron ¹	5-15	20-50	10-30	8-32-16	75 to 150
Topdress on grasses after emergence	35-50	0	0	34-0-0	100 to 150
After last cut (legumes) ² (grasses)	0	30	100	0-10-30	300
	10	20	60	5-10-30	200
Broadcast Seeding (using Brillion-type seeder, fertilizer broadcaster, etc.)					
Broadcast prior to seeding	15-25	60-150	60-150	5-20-30	300 to 700
Topdress on grasses after emergence	35-50	0	0	34-0-0	100 to 150
After last cut (legumes)	0	30	100	0-10-30	300
(grasses)	10	20	60	5-10-30	200

1. Boron may be needed on legumes. Use soil testing services to determine soil levels and amounts to be applied. **Caution:** Excess boron in bands can be toxic to plants.
2. Band seeded alfalfa should produce one cut the first year. A light application of 0-10-30 plus Boron might then be applied as a top-dressing.
3. Use the higher rate where lime and fertilizer have been infrequently applied. Otherwise, use the lower rate.

FIG.5

FERTILIZATION OF ESTABLISHED STANDS

Recommended Practice	Kg of Nutrients per hectare			Example Analysis	Rate (kg/ha)
	N	P ₂ O ₅	K ₂ O		
Stored Feed (hay or haylage):					
Over 60% legumes					
As spring growth begins	20	40	120	5-10-30	200 to 400
After each cut	0	40	100	0-10-30	200 to 300
After last cut	0	0	100	0-0-60	100 to 200
30 to 60% legumes					
As spring growth begins	50	0	0	34-0-0	150
After each cut	45	20	45	18-6-18	250
After last cut	10	20	60	0-10-30	100
Over 70% grass					
As spring growth begins	75-1100	0	0	34-0-0	225-300
After each cut	75-100	20	75-100	18-6-18	390-550
After last cut	10	20	60	5-10-30	200
Pasture:					
Over 60% legumes					
Apply in mid-June*, late July* and early Sept.	0	20	40	0-10-30	150
30 to 60% legumes	0-50	0	0	34-0-0	0 to 150
Early spring Mid-June* and late July*	35	35	35	17-17-17	200
Early September	25	50	50	12-24-24	200
Over 70% grasses					
Early spring	50	0	0	34-0-0	150
Mid-June* and late July*	45	15	45	18-6-18	250
Early September	25	50	50	12-24-24	200
Peat Soils: Increase the above rates by 25 to 30%. Trace elements as FTE (fritted trace elements) should be added at three to four year intervals as 2% of the fertilizer mixture, i.e. 18-6-18 + 2FTE. Formulation 504 (Frit Industries) contains B, Cu, Fe, Mn, Mo and Zn.					
*Dates are approximate. These are estimates of dates when previous applications will have ceased to stimulate growth and require replenishing.					

(2) While *phosphorus* is most essential in the seeding year, a small amount may also be required annually in the maintenance fertilizer.

(3) *Nitrogen* is required for pure grass stands or mixtures with less than 50% legume. Apply fertilizer containing nitrogen in early spring and again after each cut.

(4) Where *manure* is applied, reduce the rate of fertilization according to the kind of manure and rate of application. (see Figure 5).

(5) When older grass swards lose productivity, it is more economical to reseed to a legume or legume-grass mixture than to continue high nitrogen applications.

FERTILIZING PASTURES

Forages used for pasture require the same fertilizer ratios and analyses as forage grown for hay or silage. The same general recommendations can be followed. Times of application of fertilizer may differ because pasture plants are subjected to a different management system than forages grown for stored feed. Timing of fertilizer applications, particularly nitrogen, is critical for pasture growth. Fertilizers applied for early spring pastures should have a portion of the nitrogen in the nitrate form. This stimulates early spring growth

while soil temperatures are low and soil bacteria that release and convert nitrogen to the nitrate form are not yet active. If all pasture areas are fertilized in the spring, it will be necessary to remove the forage from some areas as silage or hay. For intensive pasture production, split applications of nitrogen are required. Nitrogen is required early in the season to maintain productive species and later applications are required for adequate distribution of forage over the grazing season. When grass pastures are heavily fertilized especially with potassium, it is important to use dolomitic limestone to minimize the chances of magnesium (grass) tetany from low magnesium forage. Split applications of potassium may be useful in producing forage with a satisfactory potassium-magnesium balance.

Manure may be used to supply part of the nutrient requirement of pastures. Applications of 20 to 30 tonnes of manure per hectare will stimulate early spring growth and favor the establishment of wild white clover. Spring applications will increase pasture production but may decrease the acceptability of the forage to livestock.

WEED CONTROL

Weed control is the process of limiting weed growth and infestations to allow efficient and profitable forage production.

Total weed eradication is expensive and not necessary for forage production. A weed control program should be designed to reduce the weed population to a level that is not economically damaging.

Weed control is an integral part of crop production. A good program starts by identifying the problem. Knowing what weeds are present in the crop allows selection of the most effective control. Take an inventory of the type and severity of weeds in the forage crop before harvest.

Divide the weeds into groups such as annuals and perennials; which should include both grasses and broadleaf weeds. This should be done on a yearly basis as it allows evaluation of the current program and provides information that may necessitate changes in that program. In addition indicate the severity of infestation of various weeds by the use of words such as: rare, scattered, occasional, common and/or abundant.

A successful weed control program will consist of two or more types of control since relying on one control program will usually allow some weeds to escape. Types of control generally fall into four (4) main categories namely; mechanical or physical, cultural or management, biological, and chemical.

Mechanical weed control is effective in new forage stands. Clipping the field in late June or early July removes the weed flowers and allows the forage to grow. This gives some control of annual weeds, but will not control perennial weeds such as quackgrass or milkweed. Mechanical weed control methods also include most of the cultivations done to prepare the seed bed.

Cultural weed control is the practice of growing a healthy, vigorous forage crop that will out-compete weeds. All practices that improve crop growth will help reduce weed populations. Choose a well adapted variety, lime and fertilize as recommended by a soil test, plant as early as possible and fertilize older stands. A vigorously growing legume or grass crop leaves little space for weeds.

Biological weed control is practised to some extent in areas of the Maritimes to control specific weeds by introduction of diseases and insects. Insects are the most effective — an example being the introduction of the Cinnabar Moth to control Ragwort.

Chemical weed control involves the use of herbicides which inhibit the growth of unwanted plants. Herbicides are specific as to the weeds controlled, stage of crop and weed development, time and rate of application, and method of application. Herbicides are recommended only for uses and methods of application specified on the label. Always read the label before use. Herbicides should not be the only weed control method. Use them as part of a weed control program. For more information consult Publication 75 — Guide to Chemical Weed Control.

INSECTS

European SKIPPER. This insect is found in most parts of the region. The adult is an orange-brown butterfly with a 3 cm wing spread. It congregates in damp places and skips about hay fields in mid-summer. The larvae are light green, up to 2 cm long caterpillars when full grown, and are usually found in May within rolled timothy leaves where they feed. Leaf margins become irregularly notched, and when the larvae are abundant, they defoliate timothy and other grasses such as orchardgrass, perennial rye grass, meadow fescue,

etc. They will also feed on leguminous plants when other food is scarce.

Assurance of good timothy yield is dependent on damage control. Fields should be checked for the presence of these caterpillars in late May or early June, when leaves are first rolled into tubes. If extensive damage occurred in the year previous, or if there are 65 or more caterpillars per square meter, the field should be treated with an insecticide. During some years, early cutting will reduce the damage, and cutting hay before mid-July should help prevent build-up of the pest.

An introduced virus is providing control in Prince Edward Island.

ALFALFA BLOTCH LEAF MINER. This pest of alfalfa is now present in most alfalfa growing areas and causes losses as mined leaflets frequently shatter and heavy pinhole damage from feeding causes necrosis of parts of leaflets and nutritional loss.

The adult leaf miner is a small black fly which emerges in late May. It is best identified by the numerous pinhole punctures it makes in alfalfa leaves when it feeds and lays eggs. After the eggs hatch, the developing maggots or miners feed inside the leaves, eating away the center part and producing mines or tunnels that terminate in blotches. They then drop to the soil and pupate. A generation takes about a month to complete and there are three generations per growing season in this region.

In the first crop, damage may be reduced by early cutting, but subsequent infestations do not correspond to cutting dates.

Introduced and native parasites of the leaf miner are providing control of the pest. Chemical control is not recommended.

ARMYWORM. Localized outbreaks of this pest can occur. Maintain a close watch in late June and July, especially in grass fields. They are best detected by examining crops just before sunset. At this time the caterpillars are moving up on the plants.

Control consists of cutting the crop immediately or chemical control (See Publication 100A). Use of chemical control may limit the use of the forage — always read the label.

FOR SPECIFIC RECOMMENDATIONS ON INSECTICIDES REFER TO PUBLICATION 100A

DISEASES

All forage legumes and grasses grown in the Atlantic Region are susceptible to diseases. The prevalence of diseases depends on many factors, including the presence of sources of infection as well as favorable temperature and moisture conditions.

Legume Diseases — Some of the diseases which affect one or more forage legume crops in the Atlantic Region include root and crown rots, common leaf spot, black stem, downy mildew, powdery mildew, northern anthracnose, sooty blotch, clover phyllody and nematode diseases.

Verticillium wilt has been found in several fields in the Atlantic. While it is a serious disease, it does not spread rapidly. The disease is spread by sowing infected seed, or by moving infected plant parts (including hay) from an infected field. To prevent introduction of verticillium wilt, all alfalfa seed offered for sale is treated with a recommended fungicide. If a case of verticillium wilt is suspected, contact the area crop specialist.

Grass Diseases — Brown stripe, eyespot and brown spot are a few of the diseases affecting forage grasses in the region.

Each disease is caused by a different organism and the symptoms are different, ranging from decayed roots to spots on the stems and leaves to replacement of flower petals by leaves.

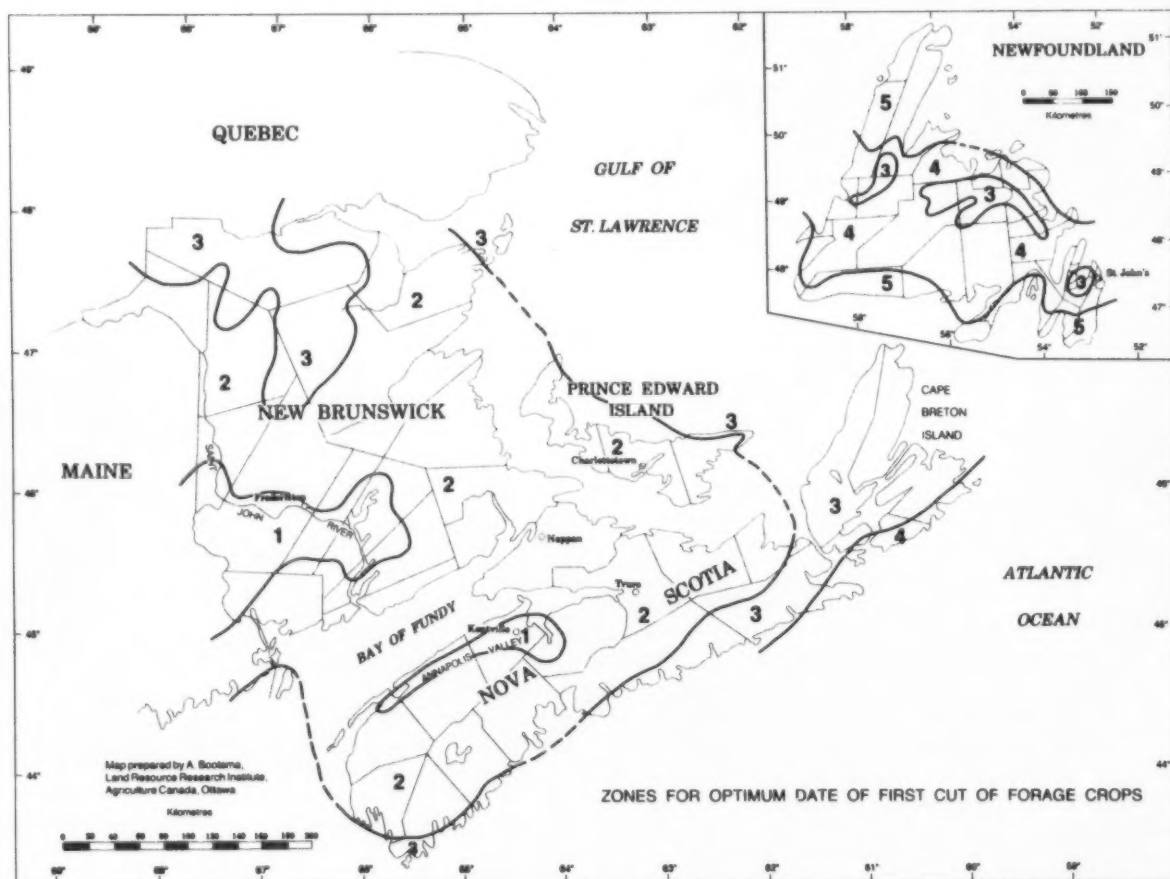
Control of diseases affecting forage crops is best achieved by prevention, and it is seldom necessary or economical to use chemicals. Good farm practices — use of resistant or

tolerant varieties when available, crop rotation, crop sanitation, and recommended cultural practices — help reduce the incidence of disease. Delayed cutting is the management factor which is most serious in the build-up of diseases on forage crops.

HARVEST MANAGEMENT

Harvesting should be timed to maximize forage yield and quality while assuring stand survival over a period of years.

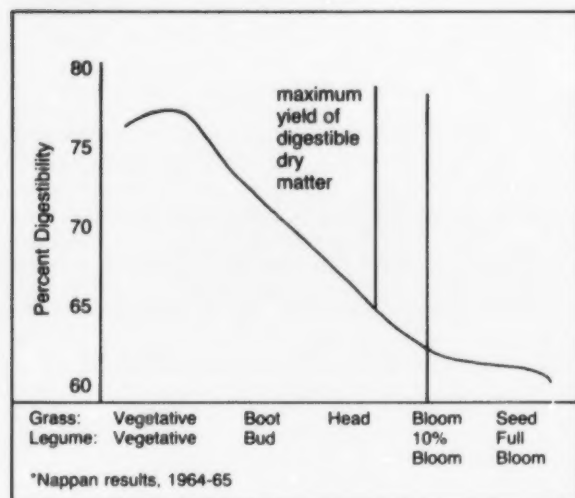
Fig. 6 Optimum date for first cut.



AVERAGE OPTIMUM DATES FOR FIRST CUT IN POSTSEEDING YEARS

Climatic zone	Crop types			
	Very early	Early	Medium	Late
	Orchardgrass Brome grass	Early timothy Reed canarygrass Flemish (early) alfalfa	Medium timothy Double cut red clover Alsike clover Standard (medium) alfalfa	Late timothy Single cut red clover Birdsfoot trefoil Perennial ryegrass
1	June 1-8	June 6-13	June 11-18	June 15-22
2	June 9-16	June 14-21	June 19-26	June 23-30
3	June 17-24	June 22-29	June 27-July 4	July 1-8
4	June 25-July 2	June 30-July 7	July 5-12	July 9-16
5	July 3 or later	July 8 or later	July 13 or later	July 17 or later

FIG. 7 EFFECT OF MATURITY ON DIGESTIBILITY OF TIMOTHY, BROMEGRASS, ORCHARDGRASS AND ALFALFA*



A high quality forage is obtained through early cutting and careful handling to prevent leaf loss. Maximum quality is obtained if the crop is cut as soon as flower buds appear on the legume. A haylage system harvesting three cuts of legume at early bud maximizes forage quality. Generally, grasses added to the mixture will reduce the protein level of the feed.

FIG. 8 EFFECT OF MATURITY ON TDN, CRUDE PROTEIN, AND ANIMAL INTAKE

Stage of Growth	TDN** (%)	Crude Protein (%)		Intake Value (kg/100 kg body wt.)
		Grass	Legume	
Vegetative	63	15.2	21.0	3.0
Bud	57	11.3	16.4	2.5
Bloom	50	7.5	11.5	2.0
Mature	44	4.1	7.3	1.5
Regrowth	52	11.3	16.1	2.6

**Total digestible nutrients

When the entire forage crop on a farm is planted to one crop or mixture, the crop must be cut within a week to get top quality feed. To increase the period of time that forage crops are at the desirable stage of growth, a range of species or varieties can be planted. Select the legumes on the basis of maturity, (see publication 100A), and match the grass to the legume. Keep in mind the length of time to harvest all the forage on a farm and the soil, climate, and other characteristics of each field when selecting the species.

As the leaves of a legume crop contain approximately 70% of the protein, it is important that they not be lost during harvest. The use of mower-conditioners, raking when the forage is wet or tough, and harvesting as haylage decrease leaf loss. Use of tedders, haybobs, or rakes when the hay is dry can result in severe leaf loss.

FALL MANAGEMENT

Legumes and grasses store food reserves in the fall. These reserves are stored as starch in the roots and are used as the winter energy supply and to provide the energy for spring growth. High levels of stored reserves are required to make the plants resistant to winter temperatures.

Root reserves are accumulated and stored in the fall during a period called the **CRITICAL FALL HARVEST PERIOD**. (See map.) Cutting during the critical fall harvest period lowers root reserves, weakens plants, and increases the chance of winterkill.

For long life of perennial stands, and for the fastest growth the following spring, do not cut or graze alfalfa or other perennials after the critical date in your area (Figure 9).

PASTURE MANAGEMENT

Good pasture is the result of good management of both the forages and animals. Productive pastures start with selection of species suited to grazing and to the field.

Long term, perennial pasture mixtures are selected in the same manner as stored feed mixtures. Start with the legume, usually Birdsfoot trefoil or a white clover, and add a grass suitable to the land and animals. Addition of lime and fertilizer to the seedbed before seeding is important as long term pastures will not be replowed for several years. After the seeding year, maintenance applications of lime, fertilizer and manure are required to keep the stand productive.

Grazing management is important to longevity and quality of the pasture. Most pasture species should be grazed down, followed by a rest period for regrowth. Legumes such as white clover, Ladino clover and Birdsfoot trefoil will stand continuous grazing provided they are not grazed intensively. Legume grass mixtures should not be grazed during the critical fall period for legumes or winterkill of the legumes may result.

Permanent pastures which are composed largely of bluegrass and wild white clover are usually less productive than newly seeded pastures that contain more productive species such as ryegrass, orchardgrass, tall fescue, ladino clover, birdsfoot trefoil, alfalfa, bromegrass and timothy. Although pastures recently seeded with improved species will give the greatest yield response to applications of fertilizer, yield of older permanent pastures can be increased by fertilizer, and manure applications.

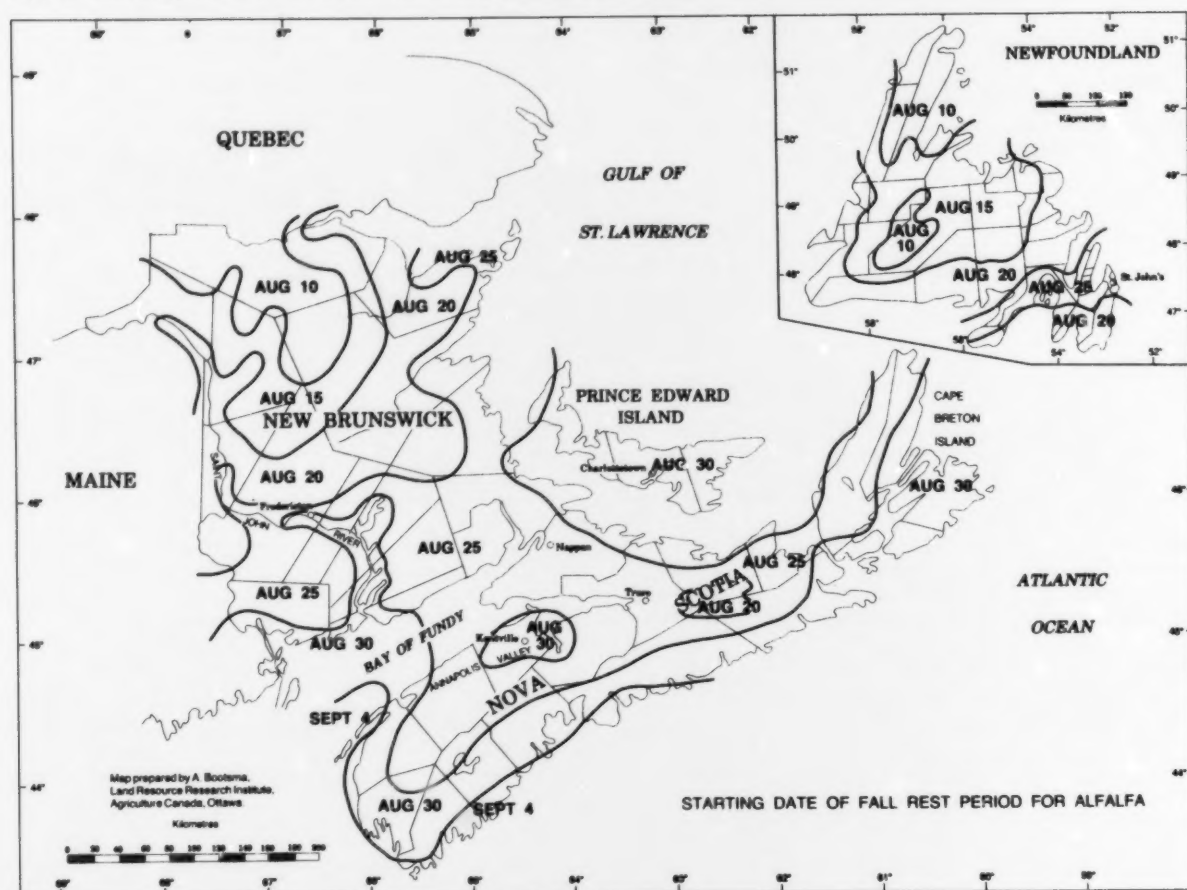
Annual crops such as kale, rape and ryegrass produce high quality pasture during certain times of the year. Further information on these crops is presented elsewhere in this publication and in Publication 136 — Italian and Westerwold Ryegrass.

FORAGES FOR SOIL IMPROVEMENT

The rotation of crops on land in a more or less regular order or sequence is a practice that should be adopted by all farmers. Forages fit well into such rotations because they reduce soil erosion, break insect and disease cycle, and when plowed will add organic matter to the soil. If a legume is used further benefit will come from nitrogen fixed by the legume.

Alfalfa is a good rotation crop where where a longterm productive forage is required and the soil is maintained at a pH of 6.0 or more.

Fig. 9 Starting date of critical harvest period for alfalfa.



To ensure an adequate level of root reserves for over-wintering and spring regrowth, do not cut alfalfa after the start of the critical harvest period in your area.

Red clover is especially useful as a one or two year break crop on cash crop farms.

Sweet clover has a deep tap root that is sometimes beneficial in improving soil structure.

Annual ryegrasses are useful as cover crops to control erosion, add organic matter, and improve soil structure. The best time to seed ryegrasses as cover crops is in the spring and early summer. Ryegrasses can be seeded until early August for erosion control, but successful establishment may be hampered by lack of moisture after seeding. Ryegrasses sown after early September have insufficient time for a good establishment and root biomass will be low.

Root mass produced in the top 15 cm of soil by crops grown for soil improvement in Charlottetown.

	Tonnes D.M. (hectare)
Anchor alfalfa	6.36
Ottawa red clover	3.64
Carroll birdsfoot trefoil	3.25
Hamadan Persian clover	2.76
Aubade Westerwolds Ryegrass	2.69
Lemtal Italian Ryegrass	0.80

FORAGE SPECIES PERENNIAL FORAGE CROPS

ALFALFA

Alfalfa is the highest yielding perennial forage available in the region. Alfalfa grass mixtures are best used for stored and green feeding as pasturing alfalfa shortens the life of the stand and risks bloat. Alfalfa fills an important role in crop rotations, improving soil structure and building soil nitrogen fertility for future non-legume crops.

Alfalfa is a deep-rooted crop that will live for several years on well drained soils, but will yield poorly and die early on poorly drained soils.

Alfalfa needs a well-limed soil; top performance will be achieved on soils limed to a pH of 6.5 or greater. Low pH results in poor yields and short life of the stand. The pH must be increased before planting and maintained with further applications of lime.

Alfalfa must be properly inoculated with the correct bacteria to take advantage of the nitrogen-fixing ability of legumes. Balsac strain alfalfa inoculant is the most effective in the region.

FIG. 10 MIXTURES FOR STORED FEED OR GREEN CHOP

Maturity	Mixture Components	Seeding Rate (kg/ha)**	Use and Soil Requirements
Very Early	Alfalfa (Flemish).....	11	Seed only on areas which are well drained. Orchardgrass is the least winter-hardy of the grasses but has more uniform yield in summer. Normally only a small portion of the total acreage should be seeded to this mixture with the objective of getting a very early first and second cut.
	Orchardgrass	7	
	or Timothy (Early)	6	
Early	Alfalfa (Flemish).....	11	For long term stands. Seed this mixture on drier soils and where timothy has not given satisfactory second growth.
	Bromegrass.....	11	
Mid Season	Red Clover.....	4	For long term stands on peat bogs and in poorly drained upland areas. After the third year, reed canary grass will dominate.
	Reed Canarygrass.....	10	
	Timothy (Medium).....	6	
Mid Season	Alfalfa (Standard)	11	For long term stands; 4 to 5 years. Seed only on well drained soil with a pH of 6.2 or higher and high fertility. Good management is essential for success.
	Timothy (Medium)	6	
Mid Season	Red Clover.....	5	Use for short term stands where drainage and pH are not adequate for alfalfa or in short rotations with an annual or cash crop (potatoes). Productive life of the stand can be extended by increasing nitrogen fertilization as the legume dies out.
	Timothy (Medium)	6	
Late Season	Birdsfoot Trefoil.....	9	Use for long term stands on areas which are marginal for alfalfa. Will not yield as high as an alfalfa mixture but retains its quality and is a good mixture for later harvest. Seed without a companion crop or remove the companion crop at an early stage.
	Timothy (Late)	2	

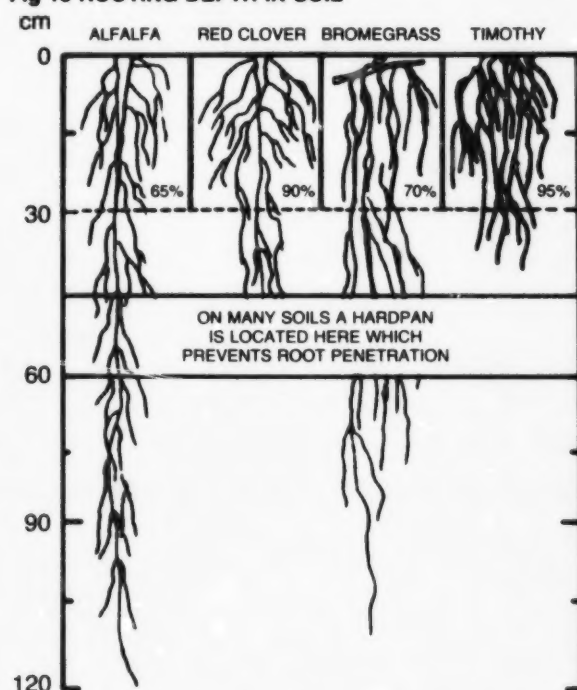
**kg/ha × 0.89 = lb/ac

FIG. 11 MIXTURES FOR GREEN CHOP OR PASTURE

Maturity	Mixture Components	Seeding Rate kg/ha*	Use and Soil Requirements
Very early	Ladino.....	2	Use for pasture, green chop or silage. Plant only on well drained areas as this mixture is subject to winter-killing. Should be used on small selected areas.
	Orchardgrass	7	
Early	Ladino.....	2	Use in place of the Ladino and orchardgrass mixture on heavier land.
	Tall Fescue	20	
Early	Ladino.....	2	Seed this on well drained locations. Careful cutting and grazing management is necessary to maintain alfalfa.
	Alfalfa (Flemish).....	5	
	Bromegrass.....	11	
Mid Season	Ladino.....	2	Useful for pasture but also very good for green chop or silage. Requires well drained sites but avoid continuous close grazing.
	Timothy (Medium)	7	
Late	Birdsfoot Trefoil.....	9	Use for pasture on areas to be seeded down for long term. Seed without companion crop or remove the companion crop early. Tolerates imperfect drainage and lower pH better than alfalfa but good production requires a pH above 5.6 and high fertility.
	Timothy (Late)	2	

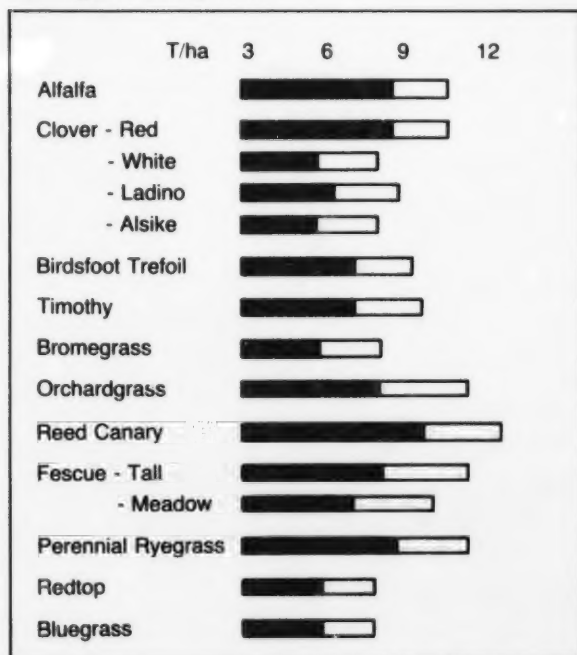
*kg/ha × 0.89 = lb/ac

Fig 13 ROOTING DEPTH IN SOIL



Alfalfa and bromegrass have deep root systems with only 65 and 70% of their roots in the top 30 cm of soil. Red clover and timothy have 90 and 95% of the roots in the top 30 cm of soil. Because of this deeper root system, alfalfa and bromegrass are more productive on light textured soils which tend to dry out rapidly.

Fig. 14 Potential yield of perennial forage species under good management.



Two types of alfalfa are available; Flemish and Standard. Flemish varieties flower earlier, and have faster and greater yielding regrowth, but are less hardy than standard types. Both Flemish and Standard types should be used on farms to stagger harvest dates.

The life of alfalfa under good field conditions varies from two to five years. Long life can be expected when two cuts are taken as stored feed, but a shorter life span will be found if the field is cropped three times or grazed.

Alfalfa can be grown alone or mixed with grasses. Addition of a grass to an alfalfa stand often reduces heaving, icing, and lodging of alfalfa while slowing weed encroachment and providing insurance of forage production when there is severe winterkill of legumes.

RED CLOVER

Red clover is a biennial or short-lived perennial. It is more tolerant to low pH and variable drainage than alfalfa. Red clover yields well in the year following seeding, but usually thins severely by the second harvest year. Red clover is difficult to make into hay and is more easily managed as haylage. Timothy is the best grass to mix with red clover for stored feed mixtures. It is not recommended in pasture mixes as it has a short life and does not tolerate grazing well. Red clover should not be included in alfalfa grass mixtures as it competes severely with the alfalfa during the seeding year resulting in a thin stand of alfalfa after the red clover dies out.

Red clover is available as double cut (D.C.) or single cut (S.C.) types. Double cut red clover reaches the cutting stage about ten days before single cut and has a stronger, more vigorous regrowth.

Red clover makes an excellent plough-down or green manure crop. If direct seeded in early spring of a favourable year, red clover will produce a four tonne hay crop in late July and a further two tonne of top growth and two tonne of roots by late fall. Best results are obtained when the red clover is inoculated with the proper species of *Rhizobia* bacteria.

BIRDSFOOT TREFOIL

On fertile soils with good pH and drainage, established trefoil will always produce less yield than alfalfa. Trefoil is less demanding than alfalfa in terms of drainage and pH, but requires high fertility and careful management for good results.

Trefoil based mixtures can be used for pasture, stored feed, or green chop, and under proper management can have a long life span. Trefoil is well-adapted to pasturing as it does not cause bloat, and is a good legume for fields that are difficult to plow and reseed. Trefoil should not be grazed until 25 to 30 cm high in the spring. For best results use rotational grazing to prevent the animals from grazing the stand too low. Trefoil requires the same fall rest period as alfalfa. Yields will be reduced in succeeding years if trefoil is harvested or grazed during the critical fall harvest period.

As a stored feed, trefoil matures later than other legumes and maintains feed value well.

Trefoil is slow to establish and does not tolerate shading in the seedling stage. Direct seeding gives best results if good weed control is practised. If trefoil is underseeded to cereals, the cereal should be seeded at not more than 50 kg/ha and removed early as green chop.

Trefoil must be inoculated with the correct *Rhizobia* bacteria for maximum yield.

Fig 15 DRAINAGE REQUIREMENTS OF FORAGE CROP

	EXCESS	GOOD	IMPERFECT	POOR
Legume	Alfalfa			
	Birdsfoot Trefoil			
	Red Clover			
	White Clover			
Grass			Timothy	
		Bromegrass		
		Orchardgrass		
			Reed Canarygrass	
		Perennial Ryegrass		

LADINO CLOVER

Ladino is a large leaved high-yielding, tall growing type of white clover. Ladino has a shallow root system which enables it to tolerate variable drainage but has poor winter survival, especially in winters with little snow cover.

Ladino is difficult to cure as hay so is best handled as haylage. For pasture, ladino should be mixed with a highly competitive grass such as orchardgrass, reed canarygrass or tall fescue hybrids. The grass reduces the high risk of bloat with a pure stand of ladino and increases yield.

WHITE CLOVER

White, wild white, and Dutch clovers refer to low growing strains of the same species as Ladino. These species will volunteer naturally on soils with good fertility and pH and will persist for many years under good grazing management. Yield and regrowth of current cultivars of these clovers are low, but they do add some quality and yield to grass pastures.

ALSIKE CLOVER

Alsike is a medium height clover with smaller leaves and flowers than Ladino. Alsike will grow on wet, acid soils but will not grow on dry soils or during hot weather. Yields can be good under high fertility and even rainfall distribution, but are not consistent from year to year. The addition of alsike to mixtures often lowers overall yield. It is therefore not recommended.

SWEET CLOVER

Sweet clover is a tall, bush-like, coarse legume. The main use of sweet clover is soil improvement as it has a deep tap root and will grow under adverse soil conditions but requires a good pH. It is not recommended for feed as it contains coumarins which may cause "sweet clover bleeding disease" in livestock. Low coumarin varieties do not survive Atlantic region winters.

The seed coat of sweet clover is very hard and requires scarification before planting. Most seed of commerce is scar-

ified when purchased. The proper strain of *Rhizobium* bacteria must be used when inoculating of this legume.

TIMOTHY

Timothy is widely adapted, easy to establish and maintain, and compatible with all legumes. When cut at the boot to heading stage, it is a good forage for all classes of livestock. Good second crops can be obtained if the first crop is removed at the heading stage and before bloom appears. Timothy contains about half the crude protein of alfalfa and has less regrowth than brome or orchard grass. It may have difficulty surviving in alfalfa fields under a three-cut system. Timothy added to a legume mixture provides insurance against loss of forage production during a year in which legumes winterkill.

Timothy will grow on acid, wet soils but both yield and quality are improved when lime and fertilizer are added, and where there are well drained soils. Since it has a shallow root system, regrowth is slow in hot dry weather.

Varieties are available in a range of maturities so that the harvest periods can be spread out while maintaining optimum quality.

BROMEGRASS

Smooth bromegrass is an excellent companion for alfalfa in a hay or haylage system. Bromegrass has early maturity, good yield, and regrowth, especially on droughty soils. It forms a strong sod and fills in as the alfalfa thins out. Bromegrass may have poor persistence in a three cut system.

Bromegrass has a deep root system and requires deep, well drained soils. It spreads by short rhizomes and requires high amounts of nitrogen if grown as a pure stand, or after alfalfa has thinned out of a mixture. Bromegrass provides early pasture and will regrow to provide good late pasture.

ORCHARDGRASS

Orchardgrass is a very early aggressive species for stored feed, green chop, or pasture. Because of an early June head-

ing date, and rapid regrowth, it should be seeded alone, or with aggressive legumes such as a Flemish alfalfa or Ladino clover. Orchardgrass must be cut just as heads emerge from the boot as quality decreases rapidly after heading.

Orchardgrass requires well-drained soils to give top yields. Surface drainage is necessary as ice or flooding will kill orchardgrass.

In some cases, heavy applications of nitrogen fertilizer in the spring may help orchardgrass to recover from winter injury but in general orchardgrass should be limited to well-drained soils.

Fig. 16 Harvest method suitability of perennial forages.

	Conserved Forage	Rotational Grazing	Continuous Grazing
Alfalfa	●	○	▽
Clover - Red	●	○	○
- White	○	●	○
- Ladino	○	●	○
- Alsike	●	●	○
Birdfoot Trefoil	●	●	○
Timothy	●	○	▽
Bromegrass	●	○	○
Orchardgrass	●	●	○
Reed Canary	●	●	○
Fescue - Tall	●	●	○
- Meadow	○	●	●
Perennial Ryegrass	●	●	○
Redtop	○	●	●
Bluegrass	○	●	●

● Highly suitable
○ Suitable

○ Not recommended crop will tolerate
▽ Crop damage

TALL FESCUE

Tall fescue is a deep-rooted, long-lived perennial, tolerant to imperfect drainage, adapted to most soils, and resistant to trampling. It is basically a bunch grass but frequent mowing or grazing will produce an even sod.

Tall fescue is adapted to pasture, or stored feed. Quality is best if the fescue is cut early and grazed heavily. Fescue makes a good fall pasture as growth is adequate and quality is maintained at that time of year. New varieties of fescue and crosses using fescues should be used for good quality, productive pastures.

MEADOW FESCUE

Meadow fescue, a perennial bunchgrass that grows 35 to 75 cm tall, is adapted to the same climate and soil as timothy but yields best on deep rich soils. It will tolerate wet soils with proper care and fertilization. Meadow fescue is a good grazing grass and is used primarily for pastures, generally in mixtures. It could be used as a stored feed if seeded in mixtures using timothy, orchardgrass, and legumes.

REDTOP

Redtop is a perennial grass with fine leaves and stems and both upright and creeping stems which form a loose sod. Redtop will grow on low fertility, acid, and poorly drained soils but yields are low. Redtop is ready for grazing about the same time as timothy. Quality is less than bluegrass grown under similar conditions, and yield is lower. The major use of redtop is pasture mixes but it can be used for stored feed on poor soils.

Redtop is often included in mixtures for ditch banks and grass waterways to prevent erosion.

BLUEGRASS

Bluegrass has a dense shallow root system and produces lush palatable growth. Bluegrass grows in the spring and is stockpiled for pasturing in the summer. Canada bluegrass maintains quality better than Kentucky bluegrass for summer feeding. Pasture production could be improved through improved management. Yield of pure stands of bluegrass do not warrant harvest as stored feed although quality can be good.

The dense root system and creeping growth habit make bluegrass an option as a bottom grass in horse pastures and to provide protection against erosion of banks.

CREEPING RED FESCUE

Creeping red fescue is a low-growing creeping grass that spreads vigorously. On ditch banks, terraces, or steep slopes the roots hold the soil while the thatch of top growth slows water movement and protects the soil surface.

Creeping red fescue can be established on most soils with good fertility. It makes a good addition to pasture mixes as a "bottom-grass" as it tolerates heavy animal traffic.

REED CANARYGRASS

Reed canarygrass is a tall, wide leafed plant. It will tolerate excess moisture, even flooding, and low pH, but produces high yields on well drained, fertile soils. Reed canarygrass loses quality extremely rapidly after heading. If grazed heavily enough or cut sufficiently often to prevent heading, it makes a good quality, high yielding forage.

Seed of this crop does not retain its germination in storage as well as most other grasses. Carry-over seed should not be planted without first having it tested for germination.

ANNUAL FORAGE CROPS

Most forage in the region is currently supplied by perennial legumes and grasses. Annual crops can be used to supplement perennial forage crops or as emergency crops to provide forage after winterkill of perennial crops.

The major use of annual forages is production during the critical fall harvest period of legumes. Selection of an annual crop must consider cost of working the land, time of year the annual forage is produced, yield, and end use of the forage. Annual forage crops work well in rotation with perennial legumes.

ITALIAN AND WESTERWOLDS RYEGRASSES

Italian and Westerwolds ryegrasses seeded early in the spring will provide high quality forage from mid-July to late fall. Ryegrass should be seeded at 15-35 kg/ha and fertilized at seeding, in July, and in August for maximum yields. Nitro-

gen in particular is essential for high yields. Italian ryegrass is suitable for pasture, while Westerwolds ryegrasses may be used for stored feed and pasture. Further information is contained in Pub. 136 "Italian and Westerwolds Ryegrasses."

OATS

Oats is the most versatile of the supplementary crops and can be seeded from early spring until late August to provide grazing within 6 weeks from seeding. Early seedlings can be left to the dough stage and used for green chop or silage. Oats for forage should be seeded at 95-135 kg/ha. Recommended grain varieties are satisfactory. Yield will be low — 2 to 4 tonnes per hectare. Oats or barley can be grown in mixtures with peas and vetch to improve protein of the forage. Yields are low and the mixture has little commercial value.

BARLEY

Barley may be used instead of oats as a supplementary crop on well-drained, fertile soils. Early seeded barley, if not needed for grazing, may be cut at the dough stage and stored in a silo, thus preserving both the grain and the straw as high quality livestock feed. The recommended grain varieties may be used.

WINTER RYE AND TRITICALE

Winter rye, when seeded in early August, will provide fall grazing, as well as very early grazing the following spring. If spring grazing is not needed, or if the crop is only lightly grazed, it can be left and harvested as grain. Careful grazing is necessary for best results. Grazing when the ground is wet

must be avoided. Rye should be seeded at 160 kg/ha. Varieties recommended for grain may be used. For further information on this crop, refer to Agriculture Canada Publication No. 1578 *Growing Fall Rye for Grain in the Atlantic Provinces*.

CORN

See Corn section of this publication.

FORAGE KALE

Kale broadcast at 2 to 4 kg/ha will be ready for grazing in August. Because it withstands frost it will continue to grow until November in some areas.

FORAGE RAPE

Rape has a slightly shorter season than kale and tends to produce off-flavoured milk. It makes good late pasture for non-milking stock. Broadcast seed at 5 to 7 kg/ha to 90 days before expected need.

SUDAN-SORGHUM HYBRIDS

Sudan-sorghum hybrids are not recommended in short season areas due to inconsistent yields and danger of prussic acid poisoning.

In longer season areas sudan-sorghum hybrids seeded at 14 kg/ha in early May will be ready for grazing in August. Do not graze or cut down during drought stress, before the crop is 75 cm high or for three days after frost to prevent prussic acid poisoning.

CORN

Corn is an important high yielding annual crop for livestock feed in the Maritime Provinces. With the continuing introduction of new, earlier maturing corn hybrids, and a number of different options of harvesting and storage methods to choose from, more farmers should look to both silage and grain corn as home-grown animal feed sources.

CORN PRODUCTION OPTIONS

Whole Plant Silage

The relatively short cool growing season makes corn as silage a choice of many farmers. Silage corn will consistently produce more total digestible nutrients per unit area than other locally-grown forage crops. Good quality silage is highly palatable, digestible and is very high in energy. Ensiling the whole plant conserves all of the energy and nutrients contained in the plant for livestock feed. Corn silage is an excellent feed for all classes of dairy and beef cattle. Supplementation with a high protein forage allows a farmer to supply most of his animal feed needs from crops grown on his own farm. However, corn harvested as silage leaves fields with little stubble and thus may substantially contribute to soil erosion, which makes field choice an important consideration.

Cribbed Ear Corn

This method of harvesting consists of picking and husking the ears, and placing them in a crib or in a well ventilated bin for storage. In general cribs must be less than 1 meter wide to allow air to circulate completely through the corn. An exposed windy site is preferred. The cribbed corn must be less than 35% moisture at harvest and all husks, silks and trash must be removed to prevent blocking of air flow through the corn.

Whole husked ears ground as meal are a suitable feed for both dairy and beef cattle with an energy content only slightly less than that of grain corn. The presence of the cob in the meal replaces some of the forage requirement in a ration, making it easier for beef cattle to switch to a full feed of grain without digestive disturbances. Ground ear corn meal is less suitable choice for feeder hogs than either grain corn or barley as hogs do not readily digest the ground cob. Leaving the stalks in the field reduces soil erosion, and helps maintain soil fertility and organic matter.

Dried Shelled Corn

Shelled grain corn is being produced in the more favorable corn growing areas of the Maritimes. Artificial drying of grain to 15% moisture is necessary for safe storage. Shelled grain corn is a suitable feed for all classes of farm livestock. As new, earlier hybrids are introduced, grain corn production may spread to other areas.

High Moisture Corn

The term "high moisture" corn refers to either grain or whole ears harvested and stored at a high moisture content; 24 to 33% moisture for shelled grain and 25 to 40% for whole ears. Both are suitable alternatives for harvesting and storing the grain portion of the plant in low heat unit areas where there is insufficient maturity for dried grain production.

High Moisture Shelled Corn — The grain is shelled from the ear and ensiled in a well-managed airtight silo or treated with an acid preservative to provide feed for both cattle and hogs.

High Moisture Ear Corn — Two harvest methods are available. A forage harvester can be equipped to pick and chop the ears which are then blown into the silo with a regular blower. A corn picker or combine equipped with a corn head can be used to harvest the corn with the grinder at the blower.

The feed value of high moisture ear corn is similar to cribbed ear corn, however, it can be harvested and stored at a higher ear moisture content than corn for cribbing.

CLIMATIC REQUIREMENTS

Corn is a crop which is at its climatic limit in the Maritimes. Only areas with sufficient heat and a long growing season can successfully produce corn in this region. Coastal areas have a long growing season, but the cooler temperatures do not provide sufficient heat for corn to reach maturity. Corn is a heat-loving crop which requires temperatures above 10°C to germinate and grows best at high temperatures. Early planting of corn in the Maritimes is difficult as heavy rainfall can delay field work and soils are slow warming to the temperature needed for germination and vigorous growth. Good drainage helps reduce both these problems. Corn is a long season crop which must reach maturity before the fall frost. Grain corn will continue to dry down after a killing frost, but no more dry matter accumulates. It is important to select a hybrid which will mature in your area.

Corn Heat Units (CHU) are calculated from daily maximum and minimum temperatures. They provide a way of rating corn hybrids and geographic regions, thus providing a basis for selecting hybrids with a maturity rating suited to the location. Most corn hybrids have a listed CHU rating, but the rating given to hybrids in other areas does not apply in the Maritimes.

The Maritimes have been divided into zones for corn production based on the CHU available in the region, (see Publication 100A, Guide to Field Crop Variety, Pesticide Selection). The Annapolis Valley and the river valleys of south-central New Brunswick have enough CHU for consistently maturing dry shelled grain corn. These areas are designated as Zone 1. They have the greatest potential for corn; both grain and silage corn can be consistently produced.

Corn grown for silage is harvested at approximately 50% moisture in the grain, or 30-35% whole plant dry matter, before grain maturity is reached, thus requiring fewer CHU. Areas designated as Zone 2 are suitable for high moisture ear corn, cribbed corn, or silage. Areas designated as Zone 3, produce an acceptable silage with only the earliest hybrids. Areas designated as Zone 4, are risky for corn production, even for silage. Corn is not recommended for these areas.

The calculation of CHU for the various locations in the Maritimes is based on the "average" data for a 30 year period. When using this information keep in mind that half the years will be better than indicated, but half the years will be worse. When evaluating the performance of a hybrid on your farm, check the CHU accumulated that season and compare them to the long term average before making a decision.

For additional information on heat unit ratings of corn hybrids and a detailed CHU map, see "Heat Units for Corn in the Maritimes Provinces", Publication ACA 79-1.

Field Selection

There are a number of key points to consider when selecting fields to grow corn.

- (1) With good cultural practices, successful corn crops are produced on most well-drained Maritime soil types. Choose fields with good, natural drainage or improved drainage (ditches or tile drains) for corn. Well drained soil is important for grain corn as the harvest may extend into the early winter when excess moisture affects travelling over the field. POORLY DRAINED SOILS ARE NOT SUITABLE FOR CORN.
- (2) Although corn is tolerant of pH readings as low as 5.5, fields should be limed to above pH 6.0 for best production and fertilizer efficiency.
- (3) Southerly facing slopes or sheltered fields may produce crops with greater maturity than exposed fields.
- (4) Fields with greater than 5% slope can present serious erosion problems especially in silage corn production.
- (5) Fields subject to early fall frost should be avoided where possible.
- (6) Fields reasonably close to the silage storage area reduce transportation time and expense. Corn silage is 65-75% water.
- (7) Distance to manure sources should be considered in choosing corn fields. Corn is one of the most efficient utilizers of the nutrients in manure. Spring incorporation of manure is the best method of utilization. Fields which allow early travel in the spring are an advantage.
- (8) Corn offers an excellent opportunity to clean fields of certain weeds, notably Quackgrass. Attention must be paid to a planned approach to weed control and the possible residue effects of certain herbicides on subsequent crops.

Corn As Rotation Crop

Many farmers find that corn offers advantages in a cropping rotation system beyond its yield advantage.

Some points to consider are:

- (1) Corn makes excellent use of manure. Large amounts can be applied without fear of lodging and as manure can be incorporated, the nutrient value is maintained for the crop.
- (2) Corn production allows for a break in the forage crop cycle. A sod bound condition can be broken with a year or two of corn.
- (3) A wide range of possible chemical and cultural weed controls are available to clean up fields for other crops such as grain or legume forages. A well designed crop rotation rotates both crops and weed control methods so no one species of weed has a chance to build up.
- (4) Corn production spreads the workload on many farms. It is planted later than spring cereals and harvest is a single operation later in the fall after work on other crops is finished.
- (5) Corn provides a high energy feed to balance the protein produced by good quality forages.

The most practical rotation usually involves 1 to 2 years of corn followed by some other crop. Continuous corn, particularly on sloping ground leads to problems of soil degradation and ultimately erosion. Rotations with forage crops lessen this problem.

In some areas aerial seeding of fall rye in mid-August has provided a suitable cover crop to reduce erosion. Excess chemical residues may reduce the growth of the rye. Fall plowing should be avoided on fields subject to erosion.

Hybrid Selection

New hybrids are continually being evaluated in the Maritimes to select very early maturing hybrids with strong stalks, high yielding ability, and resistance to insects and diseases. MANY CORN HYBRIDS ARE AVAILABLE, BUT ONLY THOSE ON THE RECOMMENDED LIST HAVE PROVEN THEIR ABILITY TO PERFORM SATISFACTORILY UNDER MARITIME CONDITIONS. SEE THE RECOMMENDED CORN HYBRID LIST PUBLISHED EACH YEAR IN PUBLICATION 100A (FIELD CROP GUIDE TO VARIETY, HERBICIDE AND PESTICIDE SELECTION) OR THE YEARLY EVALUATION TRIAL REPORT AVAILABLE FROM YOUR AGRICULTURAL OFFICE TO SELECT A HYBRID SUITABLE FOR YOUR AREA.

Choice of Silage Hybrids

Yield, maturity and lodging resistance are important considerations in choosing a hybrid for silage making. Corn reaching the dough stage, the time when most of the kernels are dented or glazed, makes the best silage. At this stage the whole plant contains 65 to 70 percent moisture. The highest yielding hybrid which generally reaches this stage before frost damage occurs is the best one to select. It is a common error to choose late-maturing hybrids which look attractive due to vigorous growth characteristics. Good quality silage requires that grain formation be well advanced by harvest time. Silage made at the proper moisture level will give the least amount of trouble from freezing and spoilage.

Choice of Grain Hybrids

The most important characteristics of a hybrid for grain production are early maturity, high yielding ability, and resistance to lodging and stalk breakage. Fall frost damage can generally be avoided by choosing hybrids with a heat unit rating no greater than the heat unit accumulation indicated for the growing region. Corn that is frozen before maturity produces grain of inferior quality, and requires additional expenditures to dry to a level safe for storage.

Stalk strength is important as mechanical pickers often miss ears on lodged or broken plants. Most breakage results from weakening of the stalk by stalk-rot or by corn borer infestation. Both tend to increase as the proportion of land devoted to corn increases. Stalk strength, resistance to root lodging and resistance to smut are given major consideration in breeding programs. Hybrids are rated for standability to enable the farmer to give this factor due consideration in choosing a hybrid.

THE MOST IMPORTANT CRITERION FOR CHOOSING CORN HYBRIDS IS PERFORMANCE UNDER MARITIME CONDITIONS, AND PERFORMANCE IS DEMONSTRATED BY THE QUALITY AND THE QUANTITY OF FEED HARVESTED FOR STORAGE

The seed of a single-cross hybrid (SX) is more expensive to produce than a three-way cross (3X) or a double cross (DC) hybrid. Single-cross hybrids (SX) usually produce more uniform and more vigorous stands. However, the wider genetic base naturally present in 3X and DC crosses may better tolerate adverse conditions should they occur during the season.

FIELD OPERATIONS

Preparing the Seedbed

Tillage operations should produce a level friable seedbed, free of large chunks of soil. A well prepared seed bed will

absorb moisture, permit aeration, and warm up rapidly, encouraging fast, uniform germination and emergence of corn seedlings. **EXCESSIVE TILLAGE SHOULD BE AVOIDED** since it may lead to soil compaction, puddling on the surface, and erosion. When an excessively tilled seedbed dries out following a rain, crusting and cracking of the surface layer frequently takes place, resulting in poor emergence and a reduced plant population. Depth of seed placement is very difficult to control in an overtilled seedbed, resulting in uneven emergence.

The elimination of unnecessary tillage operations is encouraged whenever possible. Water infiltration and drainage will be improved, while compaction, weed seed germination, costs, and energy requirements, will be reduced. Minimum tillage operations such as disking without plowing or spring plowing of stubble land using a tillage tool such as a harrow or revolving blade tiller directly behind the plow have proven successful on coarse textured soils. Planting should follow as soon as possible. When planting into fall-plowed land, such as a previous sod, a light early spring cultivation is stressed since this speeds up drying and warming of the soil permitting earlier planting. In addition, large numbers of germinating weed seeds are destroyed:

Seedbed preparation should:

- permit early planting
- maintain or improve the soil structure
- destroy weeds
- permit uniform depth and placement of seed and fertilizer
- provide conditions for rapid seed germination

Seeding Date

PLANTING CAN BEGIN WHEN THE MID DAY TEMPERATURE SOIL HAS REACHED 10°C OR HIGHER FOR THREE CONSECUTIVE DAYS AT A DEPTH OF 5 CM. Depending on location and type, soils of the Maritime area normally reach this temperature between May 7-20. Planting corn in a soil that remains below 10°C for 8 to 10 days can result in seed rot, insect damage to seed, delayed germination, and irregular emergence. Corn planted later than the first week of June is unlikely to produce satisfactory yields or maturity levels. Early planting usually results in greater maturity at harvest, even if no yield increase occurs.

Early Seeding of Corn Results In:

- greater maturity at harvest time
- shorter, stronger stalks with less lodging
- silage with higher percentage of grain
- lower grain dryings costs

Frost damage to early seeded corn does not necessarily mean loss of the crop or the need to replant immediately. The growing point of a corn plant remains protected below the soil surface for 3 to 4 weeks after planting. Although frost may kill the first 1 to 5 leaves, usually new leaves continue to emerge from the protected growing tip with little overall final yield reduction. **IF NO NEW LEAVES EMERGE WITHIN 3 TO 4 DAYS AFTER FROST, DAMAGE IS SEVERE AND REPLANTING IS NECESSARY.** Replant using the earliest maturing hybrid available.

Plant several hybrids with varying maturity dates in areas with a proven maturity advantage (ie. zone 1 or zone 2). This involves planned spring seeding dates for each hybrid, resulting in staggered fall harvesting based on hybrid maturity. Early hybrids are harvested and stored first, followed by later hybrids. Such a plan permits ensiling or picking of each hybrid at the most favorable stage of feed quality.

Seeding Rate

A uniform plant stand is essential for successful corn production, therefore, the planting machinery must be properly maintained, correctly adjusted, and operated with care and precision. A final stand of 50,000-64,000 plants/hectare is suitable for optimum corn production in the Maritime Provinces. To allow for germination losses and insect injury to seedlings, plant 15% more seeds than the intended final population. For extremely early seedings, a 25% overplanting may be warranted. The required plant populations can be obtained by various combinations of kernel spacing and row width.

Corn seed is graded into small, medium, and large size in flat or round types. Most corn seed is now sold on a unit rather than a weight basis. One corn seed unit equals 80,000 seeds.

SEED SPACING REQUIRED FOR SPECIFIED POPULATIONS

No. of Plants	Seeds required	Distance between seeds (cm) at various Row Widths			
		71 cm	76 cm	81 cm	91 cm
45,000	52,000	27	25	24	21
50,000	58,000	24	22	21	19
55,000	64,000	22	21	19	17
60,000	69,000	21	19	18	16

* Allows for 15% non-germination. Use higher rates for very early planting. (Plants per ha x 0.4 = plants per acre; cm x 0.4 = inches).

SELECTION OF PLANTER PLATES

Most older corn planters, use circular rotating plates which are available in 16, 20 or 24 cells, with various cell sizes and shapes. Seed and seed plates must be matched for accurate planting. Consult the table of suggested plates printed on the hybrid bag or tag, and then check the seed for fit in the plates. The seed should be loose enough in the cell to avoid damage, but with room for only one seed per cell. With the plates in place and the planter in raised position, rotate the drive wheel and collect several dozen kernels. Check seed for damage before making a final plate selection.

Most new corn planters are plateless and are capable of planting all seed sizes even if they are mixed together. This offers an advantage in speed and planting accuracy.

Corn planters with or without plates have settings to plant at different rates. Read the operators manual and make the suggested setting, then drive the planter with the openers up, but with some tension on the drivewheels to check the number, spacing and condition of seeds dropped by each planter unit.

Corn planters operate most accurately when driven slowly, however by using 24 rather than 16 cell plates, round rather than flat seed and larger cell seed plates, it is possible to plant at higher speeds. The plateless planters are designed to operate at faster speeds than are the plate models.

Check the operation of the planter periodically to minimize misses and plugging of fertilizer tubes while planting. Electronic devices that continuously monitored these functions are available for most planters.

Estimating Plant Population After Emergence

The following table shows the lengths of a single row equal to 1/1000 ha for different row widths:

Distance between rows (cm)	Length of row equal to 1/1000 ha (meters)
71	14.1
76	13.2
81	12.3
86	11.6
91	11.1

Plant population per ha is equal to the number of plants (within length of row specified for a given row width) x 1000.
(cm x 0.4 = inches; meters x 3.3 = feet).

Depth of Seeding — Adjust the machine to plant the seed between 4 and 6 cm deep. The seed must be placed where moisture is available but not too deep, especially on heavier soils or early in the season. Seedbed preparation is extremely important in attaining a uniform depth of seeding. In a very rough, uneven seedbed, some kernels may be too deep while others are deposited on the surface.

No-Till Corn

No-till corn planting can be advantageous in certain conditions. Its advantages are: reduced tillage, less time and machinery required at planting, less fuel used, and reductions in erosion. Some of its drawbacks are: not suitable on all soils, especially heavy soils; difficulty in getting fertility throughout the plow layer; and possible build-ups of insect or weed problems. Any problems would likely intensify with the length of time no-till is practised on a given field.

No-till corn appears suitable in the Maritimes on lighter textured soils (sandy loams, loamy sands, etc.) for planting in cereal stubble, or following corn. Until more experience is gained, it is suggested that a no-till corn field should be plowed every 3rd or 4th year, to distribute fertility within the plow layer, for control of insects (especially corn borer), and to reduce possible weed problems.

Commercial no-till planters are very expensive considering the small amounts of corn grown by Maritime producers. An alternative to purchasing a planter is to convert an existing planter into a no-till planter. The essential components of a no-till planter are: 1. Something to break open the soil ahead of the planting mechanism. 2. Sufficient weight to keep the unit in the ground. 3. Coulters, if required, to permit the movement of surface trash through the planter without plugging, and 4. Possible modifications to ensure good seed coverage.

The Charlottetown Research Station has designed such an attachment for a Ford 2 row planter. The Charlottetown unit uses 2 fluted or ripple discs attached to a homemade extension to the 3 point hitch. This extension into the bottom frame of the corn planter is attached at the top of the 3 point hitch. It supports two 100 kg weights which ensure soil penetration of the ripple discs. The fertilizer banding unit arms were extended about 5-10 cm to provide more space between the seed opener discs and the fertilizer discs to let the surface trash move through without plugging. Seed coverage was adequate, so no additional mechanism for seed coverage was required.

Fertilization of no-till corn requires extra consideration. Since nitrogen and potassium will move through the soil reasonably well, broadcast applications of N and K are suitable. Phosphorous will not move in the soil, therefore some phos-

phorous must be banded at planting. Diammonium phosphate (18-46-0) is an excellent source for banding at 100 to 150 kg/ha. If the soil test for phosphorous is medium or better, the banded fertilizer plus the soil's available phosphorous should be sufficient. Plowing after 3 or 4 years will help to redistribute the fertilizers applied on no-till corn.

SEED TREATMENTS

Between seed germination and seedling establishment, the corn plant often requires chemical protection. Seed maggots, seed rots, and seedling blights can be caused by fungi on seed or in the soil. Treatment of seed with fungicides is always good insurance against these problems, particularly if the soils are cold and wet or excessively dry. Under these conditions the rate of germination and seedling emergence is retarded, and the seed and seedlings are more susceptible to attack.

Most seed dealers pretreat corn with a fungicide before sale; however, there are exceptions. Farmers are urged to thoroughly mix a fungicide-insecticide treatment with seed in the hopper at planting time.

For effective planter box treatment, chemicals can be thoroughly mixed with seed as follows:

- Half fill the planter box with seed
- Add half the amount of chemical required for entire planter box
- Stir thoroughly with a stick (not with bare hands)
- Fill the planter box with seed
- Add the remaining half of chemical
- Stir again thoroughly

See Publication 100A Field Crop Guide to Variety, and Pesticide Selection for latest treatment compounds.

FERTILIZING CORN

Corn is a highly productive crop when properly managed. However, serious yield reductions occur when plant nutrients are not in sufficient supply. Over-fertilization is costly and inefficient and part of any excess fertilizer applied may be completely lost. THE ONLY RELIABLE MEANS OF DETERMINING THE NUTRIENTS AVAILABLE IN THE SOIL IS BY SOIL TESTING.

SOIL pH

The soil pH range suitable for corn is 5.5 to 6.5 with levels above 6.0 definitely preferred. On acid soils, either calcitic or dolomitic limestone should be applied according to soil test recommendations. Use dolomitic limestone, which contains magnesium, if soil magnesium levels are low. Applied fertilizer nitrogen results in increases in soil acidity and this acidity must be offset by lime applications.

Fertilizer Rates

The amount of fertilizer required for corn is influenced by a number of factors such as the soil's ability to supply nutrients, the previous crop and fertility program, whether manure has been or will be added, the soil type and drainage situation, climatic conditions, planting date, and corn population. SOIL TESTING IS THE ONLY RELIABLE MEANS OF EVALUATING SOIL NUTRIENT LEVELS. From soil tests, specific fertilizer recommendations can be made for each field. In the absence of such information a farmer is basically guessing. Some general guidelines about fertility may be useful.

Nitrogen — Nitrogen may be broadcast, banded, sidedressed or topdressed. To prevent fertilizer burn, topdress only when plants are thoroughly dry. Nitrogen is required for rapid early growth and large efficient plants. Lack of nitrogen causes browning of lower leaves, yellowing of the plant, reductions in yield, and a lowering of the plant's protein content. Under dry conditions or on light soils, early growth may be retarded if urea or urea mixed with diammonium phosphate is banded at high rates near the seed.

Silage corn crops harvested in the Maritimes remove from 110 to 180 kg of N/ha. A number of experiments over recent years suggest that 90 to 160 kg of applied N/ha will produce good silage yields in most situations where no manure is applied. Application rates above this are usually unprofitable. Repeated grain corn production may require less nitrogen, since some nitrogen would be returned in the corn stalks each year. Applications of manure can generally supply about 50 kg of available nitrogen/ha for each 20 t/ha applied. Reduce nitrogen applications accordingly. Legumes plowed down also contribute nitrogen.

If an excess amount of rain occurs after planting, some of the applied nitrogen may be lost through leaching before the corn has a chance to use it. A sidedressing or topdressing of 20 to 30 kg/ha of N may be required in such cases.

To determine whether the proper rate of nitrogen was used by examining the crop, examine the lower leaves of the corn stalks. If 3 to 5 of the lower leaves are dead (or nearly so) by the early dent stage and the upper leaves on the plant remain medium to dark green, the proper rate of nitrogen fertilizer was used. If fewer than 3 leaves die by early dent and top leaves remain moderately dark to dark green, too much nitrogen was used; and the rate should be decreased by 20 to 40 kg/ha. If the leaves die up to or above the ear leaf or the entire plant has a light to very light green color and the leaves near the ear leaf are yellow, too little nitrogen fertilizer was used and the rate should be increased by 20 to 40 kg/ha. (In this evaluation, consider only leaves lost because of nitrogen deficiency and not losses due to leaf blight or drought). Nitrogen deficiency starts as a V-shaped yellowing of the leaf tip, which proceeds toward the stalk, followed by gradual leaf death. Drought symptoms are almost the same as those of nitrogen deficiency, and drought will make the nitrogen deficiency appear to be worse.

If a severe drought occurs late in the season (tasseling to early dent), the above descriptions are not valid. Instead, nitrogen rates even below those recommended would have been adequate because overfertilization does not compensate for lack of water.

Phosphorus — Phosphorus is especially important for early growth and early maturity. It is essential to band some phosphorus at planting so it is readily available to young plants with their limited root systems. As the plant develops and the root system expands, most of the total required phosphorus is taken up by new roots growing throughout the soil. A high level of phosphorus throughout the plow layer is necessary at later stages of growth. On soils with high levels of phosphorus all of the required fertilizer phosphorus can be banded. Where soils are low in this nutrient, part of the phosphorus should be broadcast and plowed down or disced in before planting. Manures are usually low in phosphorus and do not provide much benefit for early growth.

Insufficient phosphorus results in slow growth and small plants. Phosphorus-deficient plants may appear dark green with reddish-purple leaf margins and tips. Cold, wet soils can temporarily restrict phosphorus uptake by the plant even

though the soil contains adequate phosphorus. Silage corn crops remove only 30 to 75 kg of P_2O_5 /ha. Fixation by the soil of some of the phosphorus applied as fertilizer in chemical forms not readily available to the plants mean that rates of application must exceed crop removal rates. However, as soil phosphorus levels build up, more and more of the "fixed" phosphorus becomes available to plants. Thus high testing soils require only a small amount of phosphorus banded at planting. Soil pH is also very important to phosphorus availability. Phosphorus becomes relatively less available as soil pH deviates from 6.5. Application rates of phosphorus may vary from 25 to 170 kg/ha depending on the soil test level of the field.

Potassium CORN HARVESTED AS SILAGE REMOVES LARGE QUANTITIES OF POTASSIUM FROM THE SOIL since corn stalks are high in this nutrient. Potassium is equally available to the plant whether broadcast or banded. Insufficient potassium results in browning of lower leaf edges, lower yields, poorly filled ears, and increased susceptibility to stalk rot and lodging. Usually when deficiency symptoms occur it is too late to correct the problem in the present year's crop.

Removal rates vary from 130 to 280 kg of K_2O /ha. Maritime soils contain potassium in mineral form which is slowly made available to plants. If corn is grown continuously, plant-available soil potassium may decline rapidly. Only soil testing can determine how rapidly this is occurring. If soil test potassium is declining or is already low, fertilizer additions should be increased until a reasonably constant soil test potassium level is being maintained. Generally, applications of 56 to 168 kg of K_2O /ha are adequate for good yields. Lower rates will be sufficient on grain corn fields where the stalks are plowed in. Much of the potassium requirement can be met by manure applications.

Magnesium A magnesium fertilizer is only required on soils testing very low in available magnesium (Mg). The most economic source of magnesium is dolomitic limestone which will both raise the soil pH and supply the required magnesium. If dolomitic limestone is not to be applied, and magnesium is required, a soluble magnesium source can be added in the fertilizer. For further information see ATLANTIC SOILS NEED LIME, Publication 534.

Micronutrients Micronutrient deficiencies in corn are uncommon, but crops should be watched for unusual symptoms. The application of manures on corn land will normally provide sufficient micronutrients. Additional micronutrients should not be applied unless soil and plant tissue analysis have confirmed that a deficiency exists. Applications based on speculation are unwise and may be toxic to the plant. See your local Soil and Crop Specialist if you suspect a problem.

For a detailed description of fertility deficiency symptoms see publication No. 535-81, SOIL FERTILITY GUIDE.

GENERAL FERTILIZER RECOMMENDATION FOR CORN CROPS

In the absence of a soil test the following "general recommendation" will provide adequate nutrients for the corn crop. However, on soils with good fertility a savings in cost could be made following a soil test recommendation.

Recommended Practice	Kg/ha of nutrients			Example Analysis	Rate** kg/ha
	N	P ₂ O ₅	K ₂ O		
Apply manure,* a good source of N and K ₂ O		20-40 t/ha solid or 50-100 cubic meters of liquid manure			
Incorporate prior to planting	80-100	27-33	80-100	18-6-18	450-550
Band at seeding***	18-36	46-92	0	18-46-0	100-200

* Nitrogen applications may be reduced by: 50 kg/ha for each 20 tonnes of cattle manure spring applied, or 50-100 kg/ha if plowing down a good legume sod (50 to 100% legume). P₂O₅ rates can be reduced by 20 kg/ha and K₂O by 80 kg/ha for every 20t/ha of cattle manure applied (see section on manure).

** Higher rate listed is for fields which have not been regularly limed, manured or fertilized.

** Fertilizer should be banded 5 cm to the side and 5 cm below seed depth. Plant injury may result from banding rates greater than 60 kgN/ha, 100 kg P₂O₅/ha or 60 kg K₂O/ha. The risk of injury is greatest on dry, sandy soils. The urea form of nitrogen should not be banded at rates in excess of 30 kg N/ha.

The only accurate way of knowing what fertilizer is needed is by having a soil test.

Fertilizer Placement

Broadcast Applications — All broadcast preplant applications of fertilizer should be plowed down or otherwise worked into the seedbed. Discing or harrowing usually mixes only the top part of the soil, which may later dry out preventing roots from feeding in this zone. Phosphorous and potassium may be broadcast in the fall and plowed under without serious loss. *Fall application of nitrogen is not recommended* as losses will be significant. Broadcast applications of up to 70 kg of actual nitrogen/ha may be made after the crop has emerged 25-30 cm. Some leaf burning may occur but is usually not serious if the nitrogen is applied when the leaves are dry. Nitrogen moves quickly into soil with the first rain. Broadcast applications containing potassium and/or phosphorus must be worked into the soil as these two nutrients will not move down into the soil.

Banding — On high fertility soils much or all of the fertilizer required for corn can be applied at planting time and **SHOULD BE BANDED 5 CM TO THE SIDE AND 5 CM BELOW SEED DEPTH**. Banding phosphorus usually aids the early growth of corn, especially on acid soils, and applying nitrogen with phosphorus in the band increases the uptake of phosphorus. Plant injury may result from banded rates greater than 60 kg of nitrogen/ha, 100 kg of phosphorus/ha, and 60 kg of potassium/ha. On light, sandy, or droughty soils, or under dry conditions, the urea form of nitrogen should not be used at banded rates in excess of 30 kg of N/ha. This same restriction applies to fertilizers containing a mixture of urea and diammonium phosphate. Urea, which is becoming a very common source of fertilizer nitrogen, presents no problems as long as the above banding precautions are observed. No restrictions are necessary for broadcast applications of urea.

Sidedressing — Sidedressing of corn is not a common practice among corn growers in the Atlantic Region. It is better

to apply P₂O₅ and K₂O by broadcasting before planting or by banding than by sidedressing unless a deficiency problem is being corrected. The use of liquid or gaseous nitrogen sources is still limited in the region and dry fertilizer is more easily handled by broadcasting. Little advantage has been found to sidedressing nitrogen, unless excessive rains after planting have caused large losses of nitrogen through leaching. Although nitrogen can be applied on the surface and will move into the soil, phosphorus and potassium, if applied after emergence, must be knifed into the soil. Sidedress applications of fertilizer must not be placed too close to the plants as severe root damage may occur unless placed half way between the rows at a depth of 3 to 5 cm. By the time the corn is knee high its roots have reached into the centre of the row. Sidedressing is only possible prior to this knee-high growth stage. Do not sidedress at rates above those recommended for banding at planting (see above).

FERTILIZER IS COSTLY AND SHOULD NOT BE WASTED. FERTILIZER APPLICATIONS BASED ON SOIL TEST ARE MORE EFFICIENT AND RETURN MORE PROFIT.

Manure as Fertilizer

Manure applications are highly recommended on corn fields. Manure supplies both plant nutrients and organic matter to the soil. The added organic matter helps to retain water and fertilizer nutrients, to maintain soil structure and to reduce erosion. Manure benefits coarse textured sandy soils by increasing water holding capacity and fine textured clay type soils by promoting stable structured units. Manure is especially advantageous on fields where corn is grown repeatedly.

The use of manure on corn can realize substantial savings in fertilizer costs, especially when the cost of disposing of the manure in other ways is considered. Time of application is very important. Since manure must fully decompose to release all of its nutrient, only about one half of the total nutrient content of the applied manure is available during the first year. If manure is applied in the fall or winter a further 50% of the nitrogen is lost to crop. Spring applied and incorporated manure supplies the most nutrients for crop use. Phosphorus in spring applied manure is of little benefit for early growth, so fertilizer phosphorus should always be banded at seeding. Large amounts of manure applied in the spring may have the undesirable effect on delaying planting. Therefore, if the fields have a large requirement for fertility, incorporate a portion of the manure in the fall and apply a lesser amount in the spring to supply some nitrogen. Manure can be topdressed on corn fields after planting and before emergence if low rates (less than 20 t/ha solid or 50 cubic meters /ha liquid) of manure are used. Liquid manure can also be injected directly into the soil as a sidedress application after the corn has emerged if the proper equipment is used.

Current values for various manures are found in appendix. By applying manure, commercial fertilizer applications can be reduced and production costs lowered accordingly.

WEED CONTROL

Both cultural and chemical weed control methods are available to corn growers. Good cultural control starts with a proper plowing job in the fall. Deep rooted perennial weeds should be cut off and completely buried by the plow. Grasses should be well covered. Harrowing in the spring will destroy many germinating annual weeds. A number of light harrow-

ings at different intervals up until seeding time will have the effect of destroying several flushes of weed growth. An aggressive corn crop, planted at the optimum time with good fertility at the recommended population will give weeds some measure of competition. Cultivation once the crop has emerged will control weeds between the rows but not within the row. Several passes with the cultivator may be necessary to keep the weeds down. Once the crop is 50 cm tall, roots extend well into the row and will be damaged by further cultivation.

With the number of herbicides and methods of application recommended for corn, excellent weed control can be achieved if the herbicide spray program is planned in advance. To plan successfully keep the following points in mind:

1. A KNOWLEDGE OF THE SPECIFIC WEEDS PRESENT IN EACH CORN FIELD allows the selection of the best treatment for those fields. Keep a record of these weeds, and be prepared to change treatments if one or more particular weeds start to build up.
2. ALWAYS LEAVE YOURSELF A SECOND CHANCE. If you start with a preplant incorporated (ppi) treatment you can apply preemergence (pre) and/or postemergence (post) treatments later if necessary. If you ignore the possibility of ppi and pre treatments and apply only a post treatment you have no other options if that treatment fails to give satisfactory weed control.
3. Obtain the current GUIDE TO CHEMICAL WEED CONTROL, Publication 75, early so you have time to read detailed instructions. Also refer to Publication 100A, Field Crop Guide to Variety, and Pesticide Selection. Order your herbicides early.
4. If the following crop is not to be corn, keep in mind the residual carry-over problems of herbicides such as atrazine and simazine.

For corn in rotation with other crops, it is wise to split applications of atrazine during the first year. One half the recommended amount may be applied and plowed down in the fall prior to first year corn and the second half just prior to or as a postemergence during the first corn year. In the second year of corn, non-residual herbicides are used so that in year 3 a crop other than corn can be used.

CORN INSECTS

Seed-Corn Maggots and Wireworms

Most commercial corn seed is already treated with a fungicide, and possibly with an insecticide to control storage insects. This treatment does not control seed maggots and wireworms in the field, so corn seed should be treated with proper insecticides just prior to planting. Prepared packets containing the correct amounts of these insecticides for treating a bag of seed are available commercially.

Wireworms are often numerous in land that has been in sod several years, particularly wet, heavy soils. Crop rotation is recommended for wireworm control. If not practical, chemical controls may be used.

Armyworm

Armyworms are attracted occasionally to weedy and grassy corn for egg laying. If armyworm larvae move into corn fields spray the border row and adjacent areas.

Potato Stem Borer

This occasional pest of weedy corn fields bores into plants at ground level early in the season. It has one generation and is sometimes confused with the later appearing European corn borer. It is a pest of grassy fields and difficult to control with insecticides. Maintain weed-free fields, borders, and fence rows by plowing, cultivation, and with the use of herbicides.

Corn Ear Worm

This insect migrates from the south preferring to deposit eggs singularly on corn silks from August through September. These eggs hatch in 7-10 days and the larvae burrow through the silk into the tips of ears. The corn ear worm is normally a tip feeder and cannibalistic. Principal damage is due to the opening of ear tips to fungal infection and bird feeding. Control can be obtained with several repetitive insecticide applications. The use of pheromone traps is recommended for monitoring adult activity when fresh silks are present.

Fall Armyworm

This southern migrant deposits eggs in bunches anywhere on the exposed corn plant from June through October, but is most prevalent in September. On small plants the larvae feed in the whorl and leaves. Later in the season the larvae attack tassels, silks and ears. Highly cannibalistic, they consume corn borers in the stalks, and are usually found at either end of the ear. Control is difficult but the foliage can be sprayed in early season to save the whorls and leaves in severe infestations. Additional application may be needed for ear protection. Pheromone attractant traps for monitoring adult activity will help time chemical applications.

European Corn Borer

This insect is the major cause of stalk breakage in the Atlantic Provinces. The adult moths emerge in late June through early July producing one generation a year. Yield loss in silage corn is seldom high enough to warrant chemical control. However, if grain corn is grown repeatedly in the same field, large populations will develop. Newly emerging tassels should be examined in mid to late July for borers or feeding injury and if more than 75% of the plants are infested, insecticide should be applied. A light infestation does not justify spraying. Control is effective only if the borers are destroyed before they enter the stalk. One properly timed application before young larvae descend the stalks is sufficient. Pheromone traps can be used for monitoring adult activity. It is most important to select a hybrid with good stalk strength. In addition, farmers should plant as early as feasible to obtain as early a harvest as possible. Harvest as soon as suitable moisture levels are reached to reduce losses from dropped ears and broken stalks which occur during autumn storms.

Miscellaneous Insects

Corn leaf aphids are generally present and abundant in many fields in late August. Populations of two predators, the transverse ladybeetle and the newly introduced seven spotted ladybeetle increase rapidly when aphids are present and prevent appreciable corn injury.

Two spotted mites may also become numerous in some years after long dry spells. These insects produce webbing on the underside of the leaves, leaf curling and stippling. Moist weather conditions, predacious mites and insects generally keep the mites controlled.

Sap beetles, a 5-6 mm reddish brown insect with 2 pale yellow spots on each side of the back, feed on decaying plant materials, sap oozing from plants, and fungi. In corn they may enter the injured ear tips and corn borer holes, but they are not themselves injurious.

For specific pest control chemicals refer to Pub. 100A, Field Crop Guide to Variety, and Pesticide Selection.

DISEASES

Corn grown in Maritime Canada suffers from few destructive diseases. However some are present, and given favourable conditions can cause damage to corn crops.

Eyespot. One of the most common diseases of corn, eyespot is a fungus disease which attacks the leaves and stems of corn. It creates round or oval shaped white lesions which can, in severe cases, cover much of the plant giving it a frosted look from a distance. Eyespot is most severe in wet seasons and in fields with the corn debris from the previous seasons crop still on the surface. Some hybrids are particularly susceptible to eyespot. Crop rotation and clean plowing of corn debris help to reduce disease severity.

Ear rot. Ear rot shows its presence in the form of pink, white, green or black moulds which develop on ears. The pink and white moulds may produce toxins which can have serious effects on livestock, especially pigs and poultry. The development of the mould is stopped when the corn is dried or ensiled, but the toxin content, if present, is unchanged. Corn stored in cribs may also develop the fungus under favourable weather conditions until the corn moisture drops below 20%.

Ear rot is particularly bad under wet conditions when harvest of corn is delayed beyond the normal time. Where birds and insects have damaged the corn by opening the cob to the weather, the disease severity may be higher.

There are a number of general preventative measures to help minimize corn disease:

1. Plant hybrids resistant to eyespot.
2. Plow under old corn stalks and leaves to help kill overwintering disease fungi.
3. Rotate corn with other crops to prevent disease build-up.
4. Minimize plant stress by: (a) avoiding plant populations that are too high for the hybrid grown; (b) maintain high soil fertility, good soil structure and good drainage.

BIRD DAMAGE

Birds may cause considerable damage to corn fields, especially to grain corn. Damage occurs during emergence when the seedlings are pulled out of the ground and also during grain filling and ripening when birds such as blackbirds, starlings, cowbirds, and crows feed on the grain. The ears are damaged either by direct bird feeding or by ear rot resulting from the invasion of secondary organisms once the husks have been loosened. Random, irregular shooting of pest birds may be advantageous. The cadavers should be left in the field.

HARVESTING CORN FOR SILAGE

THE OBJECT OF SILAGE PRODUCTION, IS TO PRODUCE PLANTS WITH A HIGH PROPORTION OF WELL DEVELOPED EARS ON WHICH MOST OF THE KERNELS HAVE REACHED THE HARD-DOUGH STAGE OR PHYSIOLOGICAL MATURITY BEFORE FALL FROST. Physiological maturity is reached when a black layer has formed at the base of the kernels. At this stage of maturity, grain filling has ceased, whole plant dry matter is approximately 30 to 35%, which is ideal, and the silage will be the most acceptable to livestock. In addition, animals can consume a smaller volume of such a dry silage than a wetter one and yet obtain the same feed value. If a silage is too wet, the animal may be unable to eat enough bulk to obtain the necessary dry matter. Corn harvested for silage after reaching the hard dough stage is often too dry to ensile well, resulting in a mouldy, unpalatable product. Allowing corn to stand very long after a killing frost results in losses in plant material and a reduction in the nutrient content of the harvested plants.

EFFECT OF MATURITY ON THE ENERGY AND PROTEIN CONTENT OF WHOLE PLANT CORN SILAGE (UNFROSTED)

Whole plant moisture %	Descriptive stage	Energy		Protein	
		As-fed basis %	Dry matter basis %	As-fed basis %	Dry matter basis %
80	Milk	12.9	64.5	1.8	9.0
75	Soft dough	16.8	67.2	2.1	8.4
70	Hard	20.8	69.3	2.4	8.0
65	dough	24.2	69.1	2.8	8.0
	Mature				

*Source — Corn Silages — Publication 92 — Ontario Ministry of Agriculture and Food

A very immature silage will seep when ensiled. This seepage causes losses in silage nutrient value as well as causing deterioration of concrete silos. The silage juices damage the silo by eroding the concrete as they wash down the walls and by being forced hydraulically to penetrate the concrete wall or staves. These two processes weaken the silo and reduce its useful life. The silage moisture content at which a vertical silo will seep depends upon its height and width.

MAXIMUM SILAGE HEIGHT TO PREVENT SEEPAGE TO PREVENT SEEPAGE

SILAGE MOISTURE CONTENT*	SILO SIZE DIAMETER X HEIGHT	
	(METERS)**	(METERS)**
72	3.6	15
70	4.2	15
70	4.9	18
68	4.9	21
68	5.5	21
68	6.1	21
65	6.1	24
65	7.3	27
65	9.1	27
63	9.1	30

* Above 72% moisture the potential for seepage increases rapidly even at greatly reduced heights.

** Meters x 3.3 = feet.

Tables based on thesis data of Lloyd Arnold, Dept. of Crop Sci., Univ. of Guelph.

The cutting knives and ledger plates on silage harvesting machinery must be kept sharp and adjusted to cut the corn plant and ear into pieces about 6-11 mm in length. If the crop being ensiled has become over mature or frosted, it is important to be certain the size of cut is 6 mm or smaller. This fine cut permits tight packing, thereby excluding air and reducing the possibility of spoilage.

Ideally the choice of hybrids and the planting and harvest schedule should permit the corn to be harvested prior to the normally expected first killing frost in the area. IF CORN IS HEAVILY FROSTED, IT SHOULD BE HARVESTED AS SOON AS POSSIBLE. As the frozen plant dries out after frost, some yield loss occurs, the nutrient content of the plant decreases especially N, K, Ca and Mg, and the feeding quality is reduced, (see table below).

STORING CORN SILAGE

The type of silo to be used should be investigated thoroughly before a corn program is initiated. The most efficient and economical setup depends on size of herd, amount of

corn, type of animal housing, and other management factors. Before making any investment in silos or mechanization, it is wise to visit and study as many operations as possible. Avoid buying or building equipment which may not be readily adaptable to long range plans. Corn silage ensiles easily if it is harvested at the correct moisture, chopped to the correct length, packed well and is covered properly to exclude air. Almost any type of air tight structure can be used. See Appendix for details on silo types and capacities and details of filling.

HARVESTING GRAIN CORN

A number of options are available to farmers interested in harvesting and storing grain corn. The choice of a system must fit both the achievable maturity of the corn in the area and the requirements for an animal feed or a product for sale. The most common methods are as follows:

1. Grain combine fitted with corn head. This arrangement, rapidly gaining popularity, provides flexibility in harvest. The grain should be less than 35% moisture at harvest for optimum results. The self propelled combine, properly equipped is a well balanced, efficient machine which can operate under more extreme conditions than pull type equipment.

Normally, only the grain portion of the corn is harvested. It may be artificially dried or stored in a silo. If the corn is to be fed to cattle or cows, the combine can be adjusted to harvest the whole cob with the grain kernels. Slight modifications to the cleaning area of the combine are necessary but the ensiled product is free of stalk, silk and trash making it a high value produce for ruminants.

2. Corn pickers. A corn picker is a 1, 2 or 3 row tractor drawn machine which may either simply husk the cobs or husk and shell the corn after the cobs are picked from the stalks. Shellers may on some machines be removed if desired. Picker huskers/shellers produce a good product if the corn is properly matured and the machine is in adjustment. Cobs picked by this method may be cribbed or ground for ensiling as high moisture ear corn. If a sheller attachment is used the corn may either be dried or ensiled as high moisture shelled corn.

On wet, muddy conditions and on sloping ground, tractor drawn picker husker/shellers are at a disadvantage compared to self propelled combines, although they are a cheaper option for farmers without access to a combine. This is especially true for farmers with smaller quantities of corn.

AVERAGE EFFECTS OF HARVEST DATE OVER 5 YEARS ON THE AVERAGE YIELD, MATURITY, IN VITRO DIGESTIBILITY, AND TOTAL NUTRIENT CONTENT OF NITROGEN, PHOSPHORUS, POTASSIUM, CALCIUM AND MAGNESIUM HARVESTED IN DK-22 CORN FOR SILAGE AT CHARLOTTETOWN, P.E.I.

Harvest Date*	Whole Plant Forage		Whole Plant <i>in vitro</i> Digestibility	Total Amount of Nutrients Harvested in Forage**				
	DM Yield	DM Content		N	P	K	Ca	Mg
(± 2 DAYS) kg/ha		%	%	-----kg/ha-----				
Sept. 14	9267	19.2	66.0	116	14.5	162	18.4	19.1
Sept. 25	10128	22.1	65.8	119	16.0	164	19.5	20.1
Oct. 6	9775	24.0	63.5	114	15.4	151	17.0	18.6
Oct. 22	9508	31.2	60.2	107	15.9	125	11.8	14.0
Nov. 3	9471	35.6	60.0	96	15.3	116	12.1	13.6
Nov. 15	9084	39.7	57.9	96	15.4	105	10.2	12.6

* First killing frost occurred on: Sept. 24/73; Sept. 25/74, Oct. 19/76, Oct. 30/77, Oct. 18/78.

**P x 2.3 = P₂O₅; K x 1.2 = K₂O; kg/ha x 0.89 = lbs/ac.

3. Snapper head equipped forage harvesters. Forage harvesters can be equipped with special corn heads which pick or snap the cobs from the corn plant similar to the action of a corn picker. The cobs and kernels however, are then ground by the harvester. A 13-19 mm recutter screen is installed to insure proper particle size of the meal before it is blown into a wagon or truck for transport to the farmers silo. The high moisture cob meal is good feed for ruminant animals. Forage harvester produced cob meal has one disadvantage from picker husker or combine type cob meal in that often the cobs are not husked properly and varying amounts of trash can travel into the chopper. This lower value material will dilute the feeding value of the cob meal. Despite the fact that this method of harvest does offer obvious advantages to farmers already equipped with silage or haylage equipment, grinding either in the field or going into the silo requires large amounts of power and slows the harvest.

STORING GRAIN CORN

Dry Storage

Artificial Dryers — Shelled grain corn with a moisture content above 15.5% will not store properly. A wide range of dryers and techniques are available to dry corn to that level. Most common types are the in-bin batch type dryers and continuous flow type dryers. The in-bin is the most popular where small amounts of corn are to be handled due to its low initial cost. It is inherently slower and usually of smaller capacity. Some in-bin designs can be made to operate on a near continuous flow basis, but most operate on single loads like the batch drier. Larger operations and grain elevators usually operate continuous flow type dryers which can be more fully automated and operated on a more efficient basis.

When drying corn from a high moisture to its safe storage state at 15.5%, it is desirable to allow a period of equalization during the process so that the moisture at the heart of the kernel has a chance to migrate to the outside. In a process called *dryeration*, this steeping of the hot kernels increases capacity of the dryer and reduces stress cracking and drying costs. **DRYING OF GRAIN THAT EXCEEDS 25% IN MOISTURE IS VERY EXPENSIVE AND SHOULD NOT BE ATTEMPTED UNLESS ABSOLUTELY NECESSARY.**

Corn Cribs — Cribbing of corn is an economical way to dry cob corn, and is well adapted for on-farm feeding. For successful drying, the kernels should contain less than 35% moisture at harvest, all of the husks must be removed, and the accumulation of loose kernels and fines in the crib should be kept to a minimum. To permit maximum drying, the cribs should not be more than 1m wide and should be placed 90 degrees to the prevailing wind in an exposed area; otherwise spoilage will likely occur due to inadequate drying in the center of the crib. Construction plans may be obtained from your local agricultural engineer.

An alternative method of drying ear corn under evaluation at the Charlottetown Research Station uses 1.2m x 1.2m x 1.2m pallet boxes. The boxes are constructed so that one side opens at the bottom (hinged at top) for unloading. A narrow wooden divider is placed in the center of the box at filling to permit better air movement through the corn. The boxes are stored outside, exposed to the wind, and placed high enough to be out of the snow.

A tractor equipped with a front end loader can bring one or more pallet boxes in for grinding as required. This system eliminates the hand labour involved in unloading corn cribs.

WET STORAGE

Silos — High moisture corn can be ensiled as shelled, ground shelled, or ground ear corn. The moisture limits for ensiling either form of shelled corn are about 24 to 33% kernel moisture. For ensiling ear corn the limits are 25 to 40% moisture. High moisture shelled corn and ground ear corn can be ensiled properly only if the silo is sealed to prevent air from entering the silage. Both may be ensiled in concrete silos, but high moisture grain will store best if it is ground first. Bunker silos will perform satisfactorily if well managed, but the corn must be well packed and covered tightly with plastic after each day's filling.

APPROXIMATE WEIGHT OF WET SHELLED CORN OR GROUND EAR CORN IN 5 CM THICK LAYERS FOR VARIOUS SILO DIAMETERS*

Material	Moisture content %	kg of material per 5 cm depth for various silo diameters in meters (m)				
		3m	4m	5m	6m	7m
Shelled corn	30	267	474	740	1066	1451
Ground ear corn	32	229	407	636	915	1246

* Source: O.I. Berge, Dept. Ag. Eng., Univ. Wisconsin.

APPROXIMATE SILO CAPACITIES FOR SHELLED AND GROUND EAR CORN*

Moisture Content (%)	Approximate weight of shelled corn (kg at 15.5% moisture equivalent) per 30 cm of height for various silo-diameters in meters (m)				
	3m	4m	5m	6m	7m
Shelled corn					
15.5	1522	2705	4226	6086	8284
24.0	1409	2505	3913	5635	7670
30.0	1321	2348	3669	5283	7197
Ground ear corn					
24	885	1573	2457	3538	4816
28	845	1502	2348	3381	4602
32	813	1445	2258	3251	4425
36	795	1415	2210	3183	4333

* Source: O.I. Berge, Dept. Ag. Eng., Univ. Wisconsin.
meters x 3.3 = feet.

Organic Acid Preservation — Commercially available organic acid preparations such as propionic and propionic plus acetic acid can be used to preserve high moisture shelled grain. By lowering the pH of the silage these organic acids either kill or prevent the growth of those organisms which cause spoilage. Application of the acid requires special equipment which sprays the chemical on the corn as it is augered into storage. There are no restrictions on the type of storage used, except that the product must be protected from rain and snow. Since the acids used are corrosive to metal, proper precautions must be employed to prevent personal injury and deterioration of equipment.

An important advantage of organic acid preservation of grain is that the effectiveness persists even after the grain is removed from storage for grinding and feeding.

FOR FURTHER INFORMATION ABOUT THE GROWING, HARVESTING, AND STORAGE OF EITHER SILAGE OR GRAIN CORN, CONSULT YOUR LOCAL SOIL AND CROP SPECIALIST.

CEREAL AND PROTEIN CROPS

Introduction

The Atlantic Provinces requires increased levels of production of quality cereal and protein crops to support a livestock industry which is capable of meeting the regions requirements. Feed grains not produced in the Atlantic Provinces, but required as livestock feed, must be imported from other areas of Canada at ever-increasing costs to the livestock producer due to increasing transportation charges.

The adoption of new production technologies and the use of spring or winter grains of high genetic yield potentials will help to meet the regions requirements for livestock feed. The Atlantic region also has sufficient land available to accommodate an increase in area devoted to grain production as either a primary or sequential crop to provide adequate cropping systems. Autumn sown cereals such as winter wheat, rye, or triticale have benefits beyond that of grain production as they may provide a greater number of options in crop sequences thus providing suitable crop rotations to assist in soil erosion and pest control. Protein grain crops such as soybeans and peas fix atmospheric nitrogen and improve soil quality while serving as a break crop to reduce the destructiveness of pest problems associated with cereals.

Successful cereal production requires careful planning and organization for variety and land selection, seedbed preparation, planting, crop maintenance, harvesting and storage to produce good quality, high yielding grain crops. The crop will require care and attention throughout the season as it is seldom possible to compensate for some previous deficiency in crop management by adjusting or adding factors at a later date.

SOIL AND CROP MANAGEMENT

Wind and water erosion, poor structure, low fertility, acidification and other problems are continually reducing the productivity of the Atlantic Region's land base and such degradation must be minimized by effective soil and crop management practices.

Soil Conservation

Cropping systems which leave the soil disturbed and bare of vegetation after autumn harvest contribute to soil erosion. Overseeding winter rye into such crops as potatoes or corn before harvest will allow the cereal to grow to the seedling stage after harvest and provide coverage to protect the soil from wind and water erosion. The winter cereal may be tilled under in the spring or if a satisfactory seedbed and crop stand is present, a cereal crop may be produced.

Protein and forage crops will enhance soil quality by improving structure, organic matter and nitrogen status. Providing that harvest and planting dates can be properly integrated, protein crops can be profitably produced in a rotation with either spring or winter cereals.

Tillage

Soil preparation methods which reduce the amount of soil disturbance such as direct drilling or techniques of minimum tillage, lower the likelihood of soil erosion. Correct incorporation of crop residues into the surface layers of the soil will improve soil structure and reduce the potential for erosion. Production of grain crops in sequence with crops such as legume forages will maintain or increase soil organic matter

level and lessen the chances of erosion. Chisel plowing and direct seeding have been demonstrated as viable reduced tillage methods within the Atlantic region.

Reducing soil tillage lowers the energy requirements for land preparation and provides additional erosion control. Such tillage methods frequently require a greater degree of pest control to control disease, insect and weed buildup. Not all soils are suitable for reduced tillage. Soil suitability should be assessed prior to adoption of new soil and crop management systems.

Adaptation

Cereals perform well under the cool moist growing conditions present in the Atlantic region. Hot dry weather in the later part of the summer may hamper grain filling and be detrimental to yield and grain quality, but may reduce the yield losses associated with diseases which thrive under moist weather. Warm, humid weather is detrimental to high yield and quality since most leaf and head diseases become more severe when moisture remains on the plant surfaces for long periods of time. Excess soil moisture is also responsible for poor performance of cereals. Barley is the most sensitive and oats least affected by wet soil while wheat is similar to barley.

Autumn sown cereals including winter wheat, rye and triticale are more exacting in their requirements than the corresponding spring planted crops. Autumn planted cereals may be successfully grown in most years when sown under conditions of proper seeding date and suitable field selection. Winter barley is very susceptible to winter injury so may be suited to only the Annapolis Valley and similar climatic zones. The use of well drained soils and protection from wind are critical as winter cereals may die if subjected to ice sheeting, frost heaving, or wind damage during winter melt periods when snow cover is lost. Continuous snow cover is most advantageous for successful winter cereal production provided that the soil freezes beneath the snow to reduce the harmful effects of snow molds, a group of pathogenic fungi which thrive at temperatures just above freezing. Winter cereals have a higher yield potential than spring cereals but require more management. Winter cereals cannot be planted in the spring because they require a period of cold temperature to stimulate them to flower and produce seed.

Soybeans require well drained soils which allow good seedbed preparation and rapid soil warm-up ensuring uniform seed germination and promotion of rhizobial bacterial activity. As soybeans are harvested in late autumn, well drained soils are required to carry harvest equipment. All legume crops including peas and fababeans require high pH (6.2-6.5) soils to ensure adequate root nodulation.

Spring canola does well as a short season oilseed crop adaptable to most cereal growing areas. Winter rapeseed/canola should be seeded two weeks earlier than the optimum planting date for winter wheat on a very well drained soil. The winter hardiness of this crop has not been adequately assessed at present, but new varieties with better quality and hardiness are being developed.

Species Selection

The nutritional requirement of each animal enterprise will dictate the preferred feed source. The feeding value of wheat, on an energy basis, is higher than barley, rye and oats. An average livestock producer must produce or purchase 3.7 tonnes of oats to equal the feeding value of 3.2 tonnes of barley or 3 tonnes of wheat. The feeding value of oats is lowest primarily due to the presence of the non-digestible

hull. The oat groat (kernel less hull) or hullless oats is very high in energy and protein quality. Triticale, a new crop appears to have potential in the Atlantic area. It is a cross between wheat and rye, with some of the characteristics of each species. Trial data indicates that both winter and spring triticale yield equal to, or slightly better than the highest yielding wheat or rye varieties. The feeding value of triticale is equal to or slightly superior to barley with a lower level of fibre.

With the understanding that each species has a different feeding value, a producer must then choose the species that best suits his land capability and required end use.

All grain species do best on well drained, high fertility, high pH soils, however some species are more tolerant to conditions that are less than ideal or they can make use of higher levels of inputs. The following figures indicate some of the requirements of cereals.

Fig. 1 Drainage Requirement

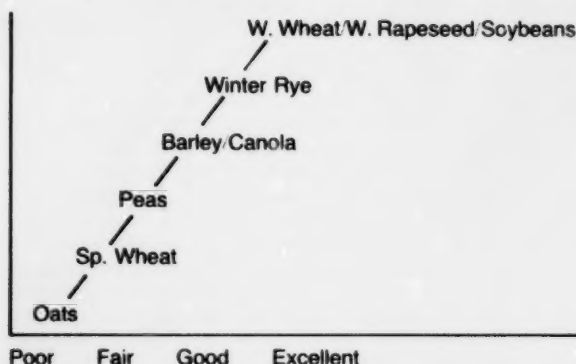


Fig. 2 pH Requirement

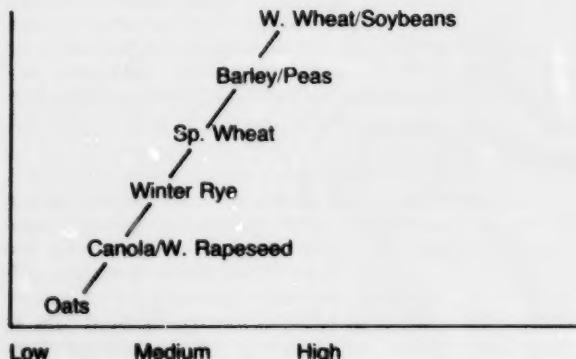


Fig. 3 P & K Requirement

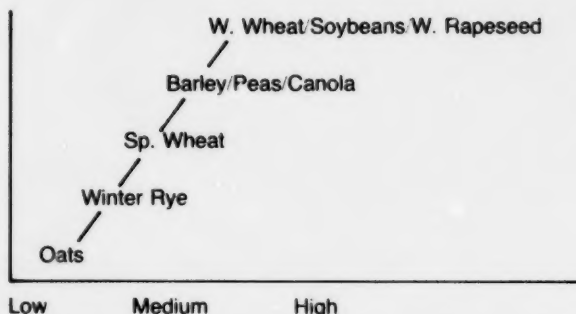
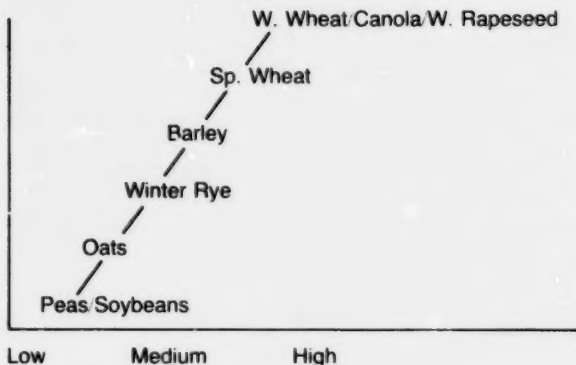


Fig. 4 Nitrogen Requirement



In general oats can tolerate poorer growing conditions and require less inputs, but yield and quality are considerably less than other grains.

Variety Selection

Varieties differ in their inherited agronomic characteristics of days to maturity, straw strength (lodging), disease resistance, yield potential and winter hardiness. Varieties should be selected to suit individual requirements keeping in mind that some variety limitations may be overcome by appropriate crop management practices. Varieties with a high yield potential, but susceptible to lodging may have this limitation overcome by the use of a plant growth regulator. Likewise early spring planting of a variety susceptible to certain leaf diseases may decrease yield loss.

Specific characteristics for each variety can be found in Field Crop Guide to Variety and Pesticide Selection, Publication 100A which is updated annually.

Seed Quality

The only method of acquiring quality seed of a chosen variety is through the use of pedigreed seed which has been produced under an inspected quality control program guaranteeing purity of identification, low weed seed content and high germination. In cereal grain, the following pedigreed seed grades exist: Breeder, Select, Foundation, Registered and Certified. The first four grades are used by seed growers

to increase seed supplies. CERTIFIED SEED is the grade intended for general crop production. Certified Seed can be identified by a blue tag on the bag which carries two identification numbers. The Crop Certificate number is issued by the Canadian Seed Growers Association and the Seed Certificate number is issued by Agriculture Canada. The first two digits of the Crop Certificate number indicate the year during which the seed was produced. The third to ninth digits identify the grower who produced the seed, the tenth digit represents the code for the generation or class issued to the crop which produced the seed, the eleventh digit represents the number of different certificates of the same status issued to the grower. If the first two digits indicate the seed has been carried over from the previous year, the purchaser should ask to see a Certificate dated within the past six months showing the germination of this seed. The Seed Certificate number is assigned to each lot of seed tagged by the seed inspector and identifies a particular lot from all other seed lots.

Non-pedigreed seed cannot be sold or guaranteed by variety name. If non-pedigreed seed is to be used, it should be tested for germination and cleaned to remove seeds of weeds and other crops. To check for germination, take a representative sample of the grain being sown and count out 100 seeds. Spread these on a moist paper towel, fold the towel and place between two plates. Keep the seeds moist and at room temperature for 7-8 days. Determine germination by counting the number of seeds which produce normal sprouts and roots. If the germination is below 75% the seed should not be used. Some seeds may be dormant due to drying. To overcome this, chill seed in refrigerator for 3-4 days before testing. Dormant seeds will germinate normally in the field.

In addition to germination, vigor of seed is also important. Seed which germinates readily and produces rapidly growing seedlings is high in vigor. High vigor seed is an additional identification of quality.

Seed of adequate germination and vigor should be treated with a fungicide before planting.

Seeding Rate

The seeding rate in kilograms per hectare of grains should be determined only after considering a number of factors including desired plant population (may vary with tillering ability of species and variety), kernel weight, and percent germination of the seed lot being used. The desired plant population (plants/m²) can only be accomplished if seeding rates are adjusted to accommodate seed weight. Seed lots of different seed weights will contain a different number of seeds in the same weight of grain. For example a seed lot with a seed weight of 30 g/1000 seeds will have 33,333 seeds/kg while a seed lot of 40 g/1000 seeds will contain only 25,000 seeds/kg. If both these seed lots were planted at the same weight/ha there would be a 33% difference in the actual seeding rate. In order to ensure the desired amount of viable seed is being planted the rate must also be adjusted to accommodate the specific germination percentage of the individual seed lot being used.

Seeding Time

Spring grains should be sown as early as the land can be prepared satisfactorily. Early seeding gives the crop more time between emergence and maturity, providing a longer growing period for plant development. Under average conditions, each week's delay in spring seeding of grain beyond the first date when soil conditions are favourable, results in approximately 10 percent reduction of total yield.

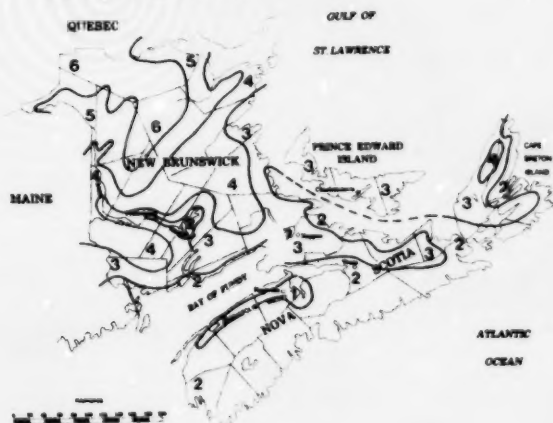
Fig. 5 Seeding Rate of Grains (kg/ha)

Seed Sample wt of 1000 seeds (g)	Viable Seeds/M ²				
	250	300	350	400	450
30	75	90	105	120	135
35	87	105	123	140	158
40	100	120	140	160	180
45	112	135	158	180	203

An early sown grain crop is more resistant to most disease and insect damage because it is at a more advanced stage of growth when attacked. Higher yields of well filled grain with a higher weight per unit of volume result from early seeding. Early sown grain is short strawed with increased resistance to lodging. Such stands are therefore able to accommodate additional nitrogen applications for increased yield and protein content. Early sown spring grain matures early, escaping many fall storms and wet soil conditions during combining.

Seeding date also has an important influence on the performance of winter cereals. Seeding before the optimum seeding date produces plants with excessive top growth which are susceptible to disease and lodging. Seeding after the optimum seeding date results in plants that are not well established before freeze-up, making them more susceptible to winter injury and delaying growth the following spring. Zones of optimum planting dates have been established based on autumn temperatures in each region (see Figure 6). For best results, seed within the optimum period indicated for your area. Some variation in optimum planting period may occur within zones due to local factors, for example, sheltered southfacing slopes. Recommended dates may need some adjustments based on local experience. Differences in autumn weather between years will also cause the optimum dates to vary.

FIG. 6 ZONES OF OPTIMUM SEEDING PERIOD FOR WINTER GRAINS BASED ON CLIMATIC DATA



ZONE	DATE
1	Sept. 10-25
2	Sept. 5-20
3	Sept. 1-15
4	Aug. 27-Sept. 7th.
5	Aug. 22-Sept. 2nd.
6	Aug. 10-Aug. 27th.

Note — Production of winter grains in zones 5 and 6 is very risky. All other Agronomic factors must be suitable in each zone.

Seeding Methods

Cereals are usually seeded with a grain drill or by broadcasting. The method chosen should permit the earliest and most rapid seeding of spring cereal on existing soil conditions. Objectives are to maintain consistency of seeding rate, depth and seed coverage for uniform germination and emergence. These objectives are usually easier to achieve with drill seeding than broadcasting. However, many operators are obtaining good results with the latter method by harrowing lightly after broadcasting, to cover the seed.

Under normal conditions cereal grain is sown approximately 2.5-3.5 cm deep. Depending on soil texture and moisture, rolling immediately after seeding may be helpful to pack loose, dry soil more firmly around the seed to improve uptake of moisture. Avoid packing or rolling land which is damp as it may crust. Rolling these areas after the grain has emerged is a safer practice.

Flotation Spring Seeding

Flotation seeding is used to plant spring cereals on lands that normally remain wet in the spring until well beyond the optimum planting date. Tractors equipped with flotation tires are used to plant soon after ground frost has come out. The best time is when the top few centimetres of soil begins to dry, but the main portion of the plowed area may be very close to field water capacity. Fields to be seeded in this method should be fall plowed with special care to ensure a smooth soil surface since spring tillage will be very minimal.

Several approaches have been used to facilitate the planting process, but the most commonly used method is to broadcast the fertilizer, harrow the field with a light cultivator to a shallow depth (5-10 cm), broadcast the seed and then cover with a chain harrow. In some cases the fertilizer and seed are applied and then incorporated by harrowing.

This practice should only be followed when adequate flotation equipment is available to avoid soil compaction and when the fields are sufficiently damp that conventional seeding will be delayed beyond an acceptable date.

Tramlines

Tramlines are unseeded parallel rows established at planting time in cereals to accommodate the wheels of equipment used for precise applications of fertilizers, plant growth regulators and pesticides. These missing rows do not contribute to lower yields and they avoid the late maturing low quality harvest caused by grain damaged by tires of application equipment. The distance between the unseeded rows of a tramline set must correspond to the tire spacing of equipment to be used for the application of additional management inputs.

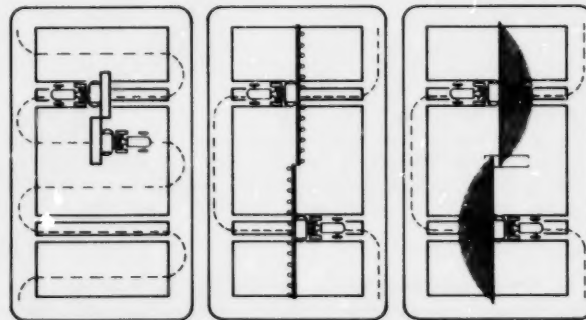
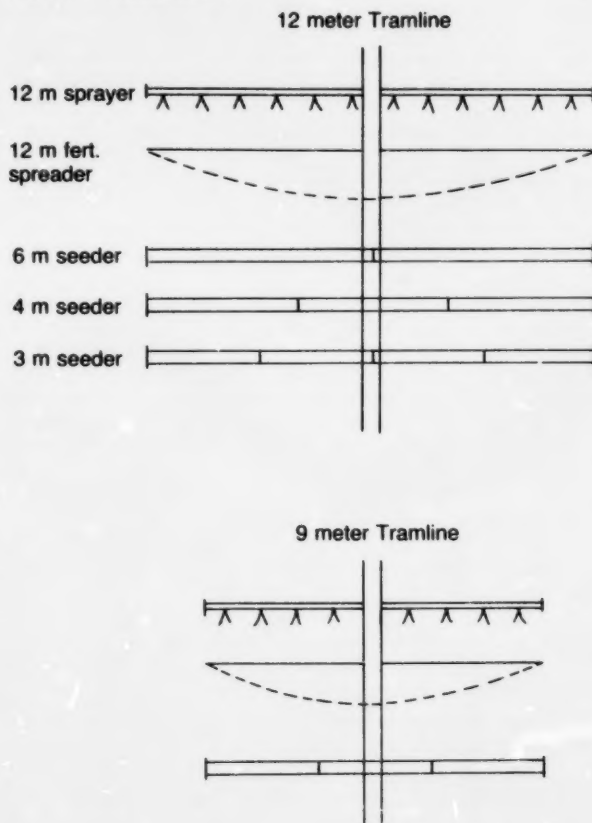
The distance between sets of tramlines is usually a multiple of the seeder width and must match the effective application distance of both sprayer and fertilizer applicator. A popular tramline spacing is 12m, which can be accomplished by using either a 6m, 4m or 3m wide seeder, (Fig. 7). Producers with narrower spray booms and fertilizer applicators may wish to use a tramline system with a 9m wide spacing (Fig. 8).

The location of the tramline space is accomplished by closing the appropriate drill spout/spouts, either permanently as in the 6m seeder making a 12m tramline or opening and closing at the proper pass, e.g. 4m machine making a 12m tramline would require them to be closed every third seeder pass.

The pneumatic type air seeders are best suited for this

system as the delivery tubes can be closed off at the distributor head. Conventional type seeders have been successfully modified to establish tramlines by mechanically opening and closing drill spouts, using a lever from the tractor seat or a remote hydraulic cylinder.

FIG. 7 TRAMLINES



A simple method for forming tramlines is to close the two drill coulters which match the wheel spacing of equipment (left). These tramlines can be used later for entering the crop to apply fungicides (centre) and fertilizers (right).

In establishing a tramline system two complete sets of tramlines should be made around the outside of the field. This allows adequate room to use the inside tramline to turn at the end of the field without concern that a slightly wide turn may result in a sprayer boom contacting an obstruction on the edge of the field. After the two outside tramlines have been established seeding should start on the straightest, longest side of the field and progress across the full width of the field. Where a field has no obvious straight side a pass can be made the length of the field to establish a reference point. Seeding is then done on either side of this initial pass until the field is completed.

The tractor used for spraying and fertilizing should have the narrowest tires possible to lessen the required width of the unseeded tramline and reduce excessive damage along the edges of the tramline.

Tramlines are most helpful to the grower who makes several passes through his crop during the growing season, but producers who are applying only a herbicide and one top dressing of fertilizer during the growing season should find the increased accuracy in application of these inputs provided by the tramline system justifies the extra effort of establishment.

Fig. 8 Growth Stages of Cereals

Recommendations on the timing of herbicides, supplementary nitrogen, foliar applied plant growth regulators and fungicides are made so crops receive the required treatments at proper stages of growth for maximum benefit rather than

by calendar date. In the Zadoks growth scale, plant growth is measured on a scale of 0-100. Growth is divided into 10 principle stages each of which is further subdivided into 10 stages.

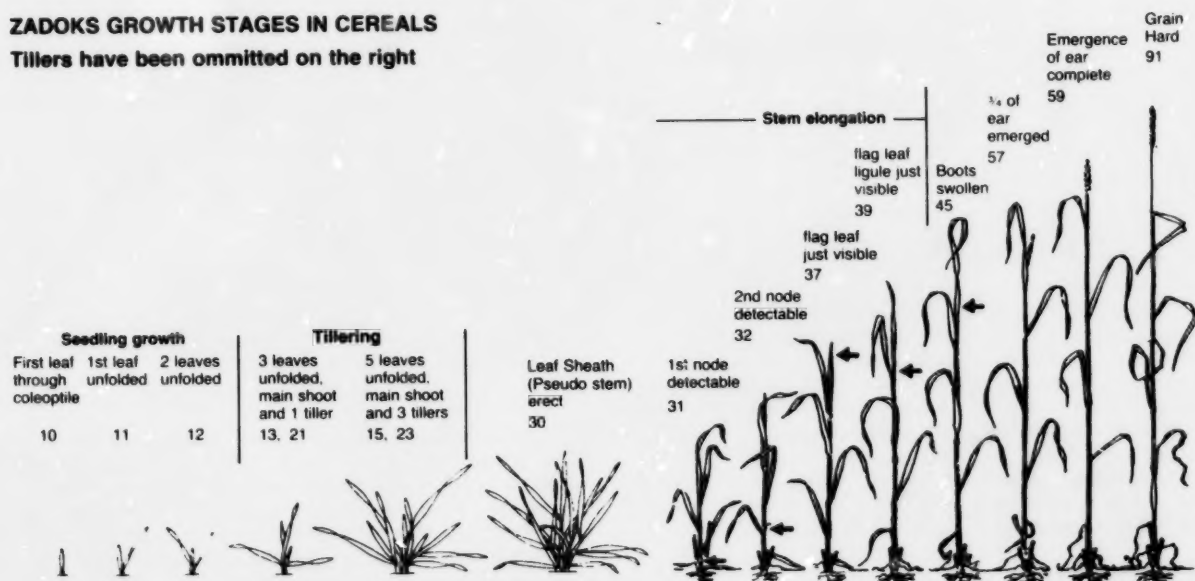
Main Zadoks growth stages of cereals

0 - 9	Germination
10 - 19	Seedling growth
20 - 29	Tillering
30 - 39	Stem elongation
40 - 49	Booting (first awns visible at 49)
50 - 59	Head emergence (complete at 59)

60 - 69	Flowering (half completed at 65)
70 - 79	Milk development (watery ripe at 71)
80 - 89	Dough development (dough hard at 87)
90 - 99	Ripening (harvest can start at 92 when seed not dented by thumb nail)

ZADOKS GROWTH STAGES IN CEREALS

Tillers have been omitted on the right



Seeding Down

Highest grain yields are obtained by seeding and harvesting the crop with cereal production as the primary goal. Underseeding of cereal grains with grasses and legumes is not recommended. Mixed crops maintain moist conditions around the cereal plants increasing the chance of diseases and lodging. Weed control and fertility needs are usually dif-

ferent for cereals and forages. This makes proper management of both types of plants very difficult. Forages mixed in the cereals will increase combine problems if the cereal lodges and the forage grows above the cereal. Cereal producers may wish to consider overseeding of forages into cereal stands after the herbicides have been applied as an alternate method of seeding forages. This practice will reduce the problems of

weed control and harvest operations and, provided moisture is adequate for forage seed germination, a forage stand should establish. This method, from a forage point of view, will be less successful than a direct seeding. If cereals are seeded down to forages, seeding rates for the cereal cover crop should be reduced by 50%.

PRODUCTION SYSTEMS

Lime

Most soils of the Atlantic region are acidic because of their original parent material and the high annual precipitation which leaches elements such as calcium, magnesium and potassium, from the soil surface layer. On low pH soils, the efficiency of applied fertilizer and the activity of soil micro-organisms are reduced (Fig. 10). Soils of the Atlantic Region require frequent applications of ground limestone to maintain appropriate pH levels. The amount of lime required to reach optimum pH is best determined by soil testing. Dolomitic and calcitic limestone are equally effective in raising pH but dolomitic limestone also supplies magnesium to the soil. Cereals grow best when the soil pH is 6.0 - 6.4.

Fig. 9 Fertilizer Efficiency at various pH Values

Soil pH	Nitrogen Efficiency	Phosphorus Efficiency	Potash Efficiency	Overall Fertilizer Efficiency
pH = 6.0	89%	52%	100%	80%
pH = 5.5	77%	48%	77%	67%
pH = 5.0	53%	34%	52%	46%

When possible, soil pH should be corrected before fertilizer is applied. Liming in the fall and fertilizing the following spring is more effective than applying both lime and fertilizer in the spring. Lime applications made during the seeding year are of some benefit but do not have sufficient time to be completely effective during the season of application. Surface applications of lime on emerged seedlings are of little immediate value. For best results lime should be incorporated into soil to the depth of cultivation. For further details regarding lime see ATLANTIC SOILS NEED LIME, Pub. 534.

Plant Nutrients

Plants require sixteen essential elements for growth and development. Nitrogen (N), phosphorus (P), and potassium (K) are required in the largest amounts. Calcium and magnesium are also required in significant amounts but are generally adequately supplied by a good liming program. The sulfur from the atmosphere and soil organic matter is usually adequate for good cereal yields under most conditions in the Atlantic region. There is little evidence of deficiency of other trace elements.

Nitrogen

In cereal production, nitrogen is essential for proper plant growth and for many of the processes within the plant such as photosynthesis and protein production. When cereals follow legumes in the rotation, considerable nitrogen may be available from the soil but fertilizer nitrogen is still required for top yields. Availability of nitrogen is generally the factor which limits cereal growth in the Atlantic Region. As availability of N increases, the rate of vegetative growth increases. Higher N rates can cause increased incidences of certain cereal diseases and increased susceptibility to lodging. The optimum rate of N application will depend on the disease and lodging susceptibility of the crop. Higher rates may be used with early seedings when lodging may not be a problem or where straw residues have been incorporated. Lower rates are recommended when a legume sod has been plowed down or where lodging is expected to occur. If soils are high in phosphorus and potassium as is often the case in potato rotations, good grain yields can be obtained by application of 60-90 kilograms per hectare of nitrogen alone. Properly inoculated protein seed crops such as peas, soybeans and fababeans require only low rates of nitrogen.

The yield potential and optimum levels of N can be increased through use of fungicides for disease control and or growth regulators for lodging control. When high levels of N are used in conjunction with fungicides for disease control and growth regulators for lodging control, splitting the N application may be beneficial. When multiple or split applications of N are used, it is important that the low rates of materials (e.g. 40 kg of N or 120 kg 34-0-0/ha) be applied uniformly. Use of pneumatic fertilizer spreaders in combination with tramlines has generally given superior results to those obtained with spinner type spreaders.

For winter cereals, generally 3-4 N applications of 30-60 kg N/ha are used. Early N applications are beneficial to yield while late N applied after heading will not influence final yield, but should increase protein content. For spring cereals up to 2N applications of 30-60 kg N/ha are used with later applications most useful in increasing protein content. The total amount of N a cereal crop can utilize depends on its yield potential. If other factors allow for high yield a crop can benefit from higher N levels. Nitrogen cannot overcome limiting factors such as drought, late seeding, or diseases and optimum N level will be lower under such conditions. Integrated management systems utilizing disease and lodging controls on high plant populations require a careful balance of nitrogen fertilizers to induce rapid growth and high yield potential.

Phosphorus

Adequate phosphorus is required for early growth, therefore high levels are needed near the developing seedling root. Applied fertilizer phosphorus in most soils of the Atlantic Region remains primarily where it is applied. Higher rates of phosphorus are required where soil tests indicate low levels of available phosphorus, where little fertilizer has been applied recently, when the fertilizer is broadcast or cereals are seeded early into cold soils. Lower rates may be used on soils testing high in phosphorus and when fertilizer is drilled with the seed. The availability of phosphorus is most dependent upon soil pH for at low pH levels the phosphorus is held in a form unavailable to the plant.

Potassium

Cereal crops require adequate potassium for good root development, kernel filling and lodging resistance. Higher

rates are required on soils testing low in potassium or where little fertilizer or manure has been applied in recent years. Higher rates are required when straw from the previous crop has been removed than when straw has been incorporated back into the soil for a number of crops.

Fertilizers

N, P, and K are generally deficient in soils of the Atlantic region, although on some fields heavy applications of fertilizer have increased P and K to high levels. Where P and K levels are high, moderate levels of fertilizer application (40-60 kg/ha) should be sufficient to maintain high P and K levels and under such conditions there is little difference between various methods of application. Where soil fertility levels are low-medium, moderate rates of fertilizer drilled beside and below the seed are more efficiently utilized than when broadcast. This is especially true of developing seedlings, levels of banded fertilizer should not exceed 55 kg of N, 110 kg of P_2O_5 or 55 kg of K_2O per hectare. Where fertilizers containing urea and diammonium phosphate are major nitrogen sources, these rates should be decreased by approximately one-half. For further details refer to "Soil Fertility Guide", Pub. No. 535-81.

Fertilizer Ratios and Analyses

The best fertilizer to use in a given situation depends on the amounts of nitrogen, phosphorus and potassium required. Results of analysis of soil samples are the best indicators of the required fertilizers, ratios and analysis for a given crop on a given field. When soil test results are not available, general guidelines should be followed.

For general conditions of low to medium levels of phosphorus and potassium, a 1-1-1 ratio is recommended. Commonly available fertilizer with 1-1-1 ratios include 17-17-17, 15-15-15 and 10-10-10. All are generally satisfactory, although handling properties may vary depending on nutrient sources used in their manufacture. The higher analysis materials are generally more economical per unit of plant nutrient. Three hundred thirty-five kilograms per hectare of 17-17-17, 370 kilograms per hectare of 15-15-15 or 560 kilograms per hectare of 10-10-10 would supply approximately 55 kilograms per hectare each of nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O). These are the maximum rates of nitrogen and potassium which can be safely drilled in with the seed.

For winter cereals, fertilizer with a 1-4-4 ratio such as 5-20-20 are generally recommended for fall application, fol-

FIG. 10 GENERAL FERTILIZER RECOMMENDATIONS FOR ATLANTIC GRAIN CROPS

Specific Recommendations Require a Soil Test

Crops	Conditions	Kg of Nutrients per hectare			Example Analysis	Rate (kg/ha)
		N	P_2O_5	K_2O		
Spring Grains Spring wheat, oats & barley (not underseeded)*	Very early seedlings (April):					
	At seeding	20-40	40-80	40-80	12-24-24	175 to 300
	Topdress	20-60	0	0	34-0-0	60 to 180
	Normal seeding date:	40-80	40-80	40-80	17-17-17	250 to 400
	Later seedlings (late May, June):	30-60	40-80	40-80	17-17-17	200 to 350
*Reduce the N on underseeded crops to ½ the above rates; P_2O_5 and K_2O should remain the same.						
Soybeans, peas	Incorporate or band (not with the seed) at planting	10-15	40-70	40-70	5-20-20	200 to 350
Buckwheat	At seeding	25-50	25-50	25-50	17-17-17	150 to 300

For above crops:

Use the lower rates of P_2O_5 and K_2O where manure, lime and fertilizer have been regularly applied. Use the higher rates if applications have been infrequent.

Winter Grains Winter wheat and rye		15-25	50-100	50-100	12-24-24 5-20-20	200 on fertile soils 300 to 500 on less fertile land
	At seeding					
	Just before spring growth begins	30-75	0	0	34-0-0	100 to 225 ¹
	Growth stage 25-30 (end of tillering) ¹	25-30	0	0	34-0-0	75 to 100 ³
	Growth stage 39-45 (boot to heading) ²	30-60	0	0	34-0-0	100-200 ³

1. This application should be increased to 40-60 kg N/ha where a final application at Growth Stage 39-45 is NOT planned.

2. This application will raise grain protein of wheat. Response will be limited on rye. Yield increases are limited. Trailing systems or aerial applications are necessary to prevent crop trampling.

3. The higher rates may cause excessive lodging of rye. (Reduce early spring application to 180 kg/ha).

lowed by a broadcast application of nitrogen in early spring and subsequent applications at later growth stages.

When high rates of phosphorus are required with medium rates of nitrogen and potassium, fertilizer with a 1-2-1 ratio such as 10-20-10 or 8-16-8 may be used. Where high rates of nitrogen and low to medium rates of phosphorus and potassium are required, fertilizer with a 2-1-1 ratio such as 20-10-10 may be used. If these mixtures are not readily available and since they may be difficult to handle under moist conditions, it may be better to apply sufficient 1-1-1 ratio fertilizer in the drill to meet phosphorus and potassium requirements and broadcast the additional nitrogen as ammonium nitrate (34-0-0) or urea (46-0-0).

PEST MANAGEMENT

Pests, including weeds, insects and diseases, are major limiting factors in the production of high yielding, high quality grain crops. While potentially destructive, the full impact of most pests can be significantly reduced by a number of preventative and curative methods. These involve the major areas of government regulation, appropriate crop management, resistant varieties and chemical control. The integration of several of these methods provides the best results.

Regulation

Numerous regulations are present which assist in preventing the introduction of new, or more difficult to control pests, into the Atlantic region. These are administered by Federal or Provincial regulatory agencies for the protection of individual growers and the entire grain industry. An example of such regulations for pest control is the licensing system for new varieties which requires oats to be resistant to Victoria blight, a very destructive disease which has been eliminated by requiring all new oat cultivars to be resistant. Another illustration may be cited in the Pedigreed Seed regulations which limit weed seed content in seed grain and requires the complete elimination of specified noxious weeds from certified seed.

Crop Management

Crop rotation and other good crop management techniques such as early seeding are effective methods for pest control. Each additional year a field is in continuous cereals increases the number of weeds, disease causing fungi, and insect pests present which are detrimental to yield. Examples of such situations includes the gradual build-up of grass weeds (particularly quackgrass), diseases such as Take-all, and insects in continuous cereal fields. A break crop denies these pests the hosts they require resulting in a decline in their population. Crop rotation facilitates grass weed control particularly if it allows for additional land cultivation. A significant yield loss due to pests may occur in the second year that cereals are planted in a field. Barley after barley has been shown to lower yields by up to 500 kg per hectare.

Pests can be quite mobile and crops to be seeded in adjacent field must also be considered. This is a particular consideration in the spread of the fungus inciting powdery mildew of wheat. If winter wheat is infected in the fall it may infect a susceptible spring planted wheat shortly after emergence in an adjacent field. If spring wheat can be planted at a distance from the winter wheat, infection will be delayed until a more advanced stage of growth of the spring wheat and thus lessen disease severity.

Integration of pest control can best be illustrated by the value of controlling grass weeds such as quackgrass in cereal fields. Quackgrass is an alternate host of the fungus causing Take-all, a severe root and basal stem disease of cereals, particularly wheat. When the weed host is eliminated, the population level of the disease causing pathogen is reduced and less disease occurs in the cereal crop. The quackgrass must be destroyed by at least the spring prior to planting winter cereals or the fall prior to seeding spring cereals.

In those areas where soil erosion is not a problem, fall plowing to bury crop debris will assist in the decomposition of the residues on which disease causing fungi and insects survive between grain crops. Early decay of such plant material in the fall will reduce the overwintering of many pests.

Resistant Varieties

A resistant variety should always be used whenever possible. Resistance may not be total and some disease symptoms may develop but even partial resistance may reduce the yield loss. Many cultivars are susceptible to a number of diseases, however, if resistance is present to even one, this is still of value in those years or circumstances when that one disease may be prominent.

Chemical Pest Control

Weed Control

Weeds compete with grain to reduce yield and cause difficulty during combining. Herbicides can give good weed control but must be selected to control the weeds present in the field to be treated. Producers should identify the weeds present in the fields each year and keep a record to help in selecting the proper herbicide. Herbicides must be used properly for maximum benefit. Herbicides should be considered a production tool and not a cure-all for poor management. Young, rapidly growing weeds are more easily destroyed than large older weeds. Consideration should be given to using tramlines when herbicides are post-emergent applied as this will result in less damage to the crop and give greater application accuracy. Late spraying gives poor weed control and may reduce yield due to crop injury; most yield depression due to weed competition occurs during the early stages of crop and weed growth.

Quackgrass infested fields should be cleaned up before seeding cereals. Summer fallowing with repeated deep cultivations through the summer and fall is an effective cultural control. Do not neglect grain fields after harvest, but use shallow cultivation as well as herbicides to control quackgrass and other weeds. Success of weed control with herbicides depends on proper application. Read and carefully follow the instructions in production guides and on the product label.

Insect Control

Population of insects such as armyworms and aphids may build up very rapidly and producers should regularly inspect their fields to detect such increases before they reach a level at which control is difficult or the crop is already damaged. Control of aphids will also reduce the harmful effects of barley yellow dwarf which is aphid transmitted. Early seeding will effectively reduce the importance of insects as the host crop in early seeded fields will be more advanced in growth when attacked and thus less liable to severe yield loss. It is frequently difficult to determine when an insect

population has reached a level at which use of an insecticide will be warranted and in such instances grower and crop specialist's experience is helpful. Under certain conditions, use of an insecticide seed treatment provides sufficient protection from some insects and eliminates the requirement for a foliar applied insecticide. In order to select the proper insecticide, careful observation and identification of the insect pest in question is required.

Disease Control

The use of fungicides can be effective in supplementing other methods of disease control. The two methods for the application of fungicides are seed treatments or foliar sprays. The application of a fungicide to the seed prior to planting will assist in controlling most seed borne diseases. Loose smut diseases of barley and wheat can be controlled only by a systemic fungicide which enters the developing seedlings at germination. Other types of smuts may be controlled by use of non-systemic fungicides. Seed treatments also protect seedlings from disease-causing fungi in the soil such as those associated with seedling blight and root rot. Improved stands are obtained through increased emergence and this may result in higher yields. Seed treatments may also significantly reduce the severity of a number of foliar diseases. All seed produced in the Atlantic region should be treated since the moist environment of this region results in a high population of disease producing fungi on seed.

Seed treatment fungicides exist as either liquids or powders. Liquid materials are best used by commercial seed treaters but powders are available for on-farm drillbox application. If a drillbox preparation is used, the following directions will insure proper seed coverage. When starting with an empty drillbox, treat sufficient seed in a separate container to cover the bottom of the seed box. This ensures that the first sown seed will be adequately treated. This initial separate treatment of seed will not be required again if sufficient seed remains in the bottom of the drillbox at refilling. Fill the drillbox to one-half capacity and sprinkle the recommended amount of treatment material evenly over the seed. Mix thoroughly with a stick until seed is covered uniformly. Uniform coverage is achieved when all seed has a pink colour. Add enough seed to fill the box. Sprinkle another layer of fungicide at the recommended rate on top and repeat mixing. *Do not mix with bare hands. Protective clothing and an approved respirator should be worn while applying seed treatments.*

If seed is being treated with liquid fungicide in a commercial treater, recommended rates must always be followed carefully. Rates of application cannot be judged by colour of seed alone, but lack of uniform colour indicates inadequate treating.

Foliar fungicide sprays have the potential for increasing yield and quality. Tramlines should be used if such fungicides are ground applied in order to increase accuracy of application and to minimize crop damage from spray equipment. Timing and advisability of application of a selected foliar fungicide is dependent on the variety grown, the disease problem to be controlled at its severity, and the growth stage of the crop.

Detailed information on pest control recommendations are contained in specific publications listed in the Appendix. Information on the relative disease resistance of recommended varieties for the Atlantic Region and on specific pesticides can be found in Publication 100A published yearly.

GRAIN GRADING

The successful production of quality grains in the Atlantic Region is highly dependant on weather conditions. Grain quality can be a significant factor in the marketability of feed grains, both to feed mills and livestock feeders. A system that determines grain quality permits grains of the same kind to be collected, purchased and sold on a quality basis.

In Canada, grain quality is assessed by a grading system established by the Canadian Grain Commission. The systems were designed to distinguish the quality of a grain in view of its intended end use and relies on two sets of Standard Grades, one for Western and one for Eastern Canada.

GRAIN GRADING IN THE MARITIMES

New Brunswick

The New Brunswick grading program operates on a voluntary basis under the supervision of the N.B. Grain Commission. Feed wheat, oats, barley, rye and buckwheat are graded at grain elevators in Grand Falls, Florenceville, Hartland, Sackville and Rogersville. A centralized grain grading laboratory located in Fredericton facilitates training, arbitration of disputes and statistical analysis of grain quality for the province.

Any producer in N.B. wishing to have grain graded can do so by submitting a sample of 1 kg in an airtight container to: N.B. Grain Commission, P.O. Box 6000, Fredericton, N.B., E3B 5H1.

Nova Scotia

The Nova Scotia Grain Commission operates centres where grain is received and graded.

The Steam Mill Center has protein testing equipment for barley, milling and feed wheats, corn, rye and oats. The Bay-head Center is equipped to do protein tests on feed and milling wheat and barley.

Any producer in N.S. wishing to have their grain graded can do so by submitting a sample to the grain graders at one of the grain centers.

Prince Edward Island

The Prince Edward Island Grain Elevator Corporation operates grain centers at Roseneth, Kensington and Elmsdale. All feed wheat, oats and barley are graded according to the Canada Eastern Grain Standard. Any farmer not delivering grain to one of these elevators may have a grain sample graded by contacting any of these centers. A protein test is available upon request.

OTHER GRAIN CROPS

Protein Crops

With the high cost of imported protein for livestock feed, more farmers of the Atlantic Region are expressing interest in home grown protein crops. Soybeans, field peas, canola/rapeseed may all be grown in this Region as sources of local grown livestock protein.

Soybeans

Soybeans are adapted to the longer frost free areas with climatic conditions similar to those for grain corn. Early maturing soybean varieties produce average yields of over 2.0 tonnes per hectare with proteins of 35 to 40 percent. Raw, crushed soybeans may be included as a protein supplement in dairy and beef cattle rations without further processing, but before being fed to hogs or poultry, soybeans require heat treatment.

Several soybean varieties are now available which mature in the Atlantic Corn Heat Unit Zones I and II. This includes much of the Atlantic Region. Soybeans make a good rotation crop, particularly for cereals since they break disease cycles and improve soil fertility through their nitrogen fixing capability. Soybeans have potential in many cropping programs in the Atlantic Region.

Soil and Fertilizer

Since soybeans require high soil temperature for uniform germination and are harvested late in the fall, soils must be well drained. Soil fertility levels should be medium to high with soil pH above 5.6 and preferably above 6. Although soybeans in combination with rhizobium bacteria have the ability to fix nitrogen, low levels of N fertilizer applications are generally recommended. Fertilizer N is important when soybeans are grown for the first time in a field where nodulation may be at levels lower than is necessary to produce high yields. Specific requirements for lime and fertilizer should be determined from soil tests. Fertilizer for soybeans should either be broadcast and harrowed in before seeding or banded at least 5 cm below and 5 cm to the side of the seed. Drilling fertilizer directly with the seed can seriously reduce stands.

Varieties

Choose a variety which will mature with the heat units normally obtained in your area. Other considerations to include in variety selection include market related characteristics such as hilum color, protein and oil content, and sensitivity to herbicides. For detailed varietal descriptions, see Field Crop Guide to Variety, and Pesticide Selection, Publication 100A.

Inoculation and Seed Treatment

Soybeans require inoculation with specific soybean rhizobia. This may be done by treating the seed following manufacturers recommendations or by use of a soil implant type material. Soybean inoculum must be protected from prolonged exposure to heat and light which will decrease its effectiveness. Where insects such as seed maggots or wireworms are likely to be a problem, seed treatments containing fungicides and insecticides are recommended. Careful attention to application techniques following manufacturers recommendations is required to prevent reduced germination. Careless applications of such seed treatments may also interfere with nodulation and the crops ability to fix nitrogen.

Seeding Methods and Rates

Currently available early maturing varieties of soybeans produce small plants with little branching compared to varieties available in longer season areas. Solid seeding or use of narrow row spacing is generally recommended in the Atlantic Region. Grain drills, if carefully adjusted to control depth and prevent seed cracking, can be used for seeding soybeans. Uniform seeding is easier to achieve if a firm, level seed bed is obtained by shallow cultivation. Seeding rates in

the 100-150 kg/ha range are recommended with the lower rate adequate under ideal conditions of depth and spacing control. The higher rates are required when depth and spacing are less uniform.

Weed Control

Soybeans cannot compete with broadleaf weeds, annual grasses or quackgrass. Good weed control in soybeans during the first 1-4 weeks after emergence is necessary. Herbicides are available and recommended for controlling both broadleaf weeds and grasses in soybeans and should be selected for control of specific weeds present. Growers should select their best fields which have low weed populations. Fields should be selected the year before soybeans are to be grown so that weeds can be identified and herbicide programs selected that will give control of the weed species present. Atrazine residue can severely injure soybeans. Select fields which have not received more than 1.7 kg/ha of atrazine the previous year. Proper time of application of each herbicide is stated on label and in production recommendations. Growers should consult these and follow recommendations carefully, as in many cases, the margin between adequate weed control and crop damage is narrow.

Harvesting and Storage

Soybeans are ready for harvest soon after leaves turn brown and fall off. This generally can be expected in late September or October depending on seeding date, variety and growing conditions. Moisture levels should be below 20% for harvest. Combines should be adjusted according to manufacturers specifications to obtain a clean sample of undamaged beans. Generally, lower cylinder speeds (500-700 rpm) and wider concave and sieve openings are required for soybeans than for cereals. Care must be taken to harvest bottom pods which are close to the ground. Flexible cutterbars and level fields improve the ability to harvest bottom pods.

Safe moisture levels for storage depends on air temperature and volume stored. Soybeans may be held at 14-16% moisture at low temperatures but at this moisture level may deteriorate when temperature increases in the spring. For summer storage moisture levels should be less than 12%. For short term storage, soybeans may be held at moisture levels up to 18% if the bins are adequately aerated.

Uses

The major use for soybeans produced in the Atlantic region is as a protein supplement for livestock feed. For ruminants they may be used directly using normal milling practices for small grain with some modification to avoid excessive oil coating of milling equipment and to avoid rancidity in the oil following crushing. Feeding to non-ruminants require soybeans to be heat treated to destroy digestion inhibitors. Before soybeans are introduced to a feeding program, a livestock nutritionist should be consulted to insure that a properly balanced ration is used.

Field Peas

Peas are well adapted to the cool Maritime climate. Average yields of 2.0 tonnes per hectare of dry field peas are being obtained with protein content about 23 percent.

Peas are a legume that should be grown on well drained soils free from quackgrass. Early to mid-May seeding is recommended to ensure maturity and to reduce disease infections.

A seed treatment of a fungicide and insecticide is recommended.

Field pea rhizobia does not occur naturally in the soil and therefore inoculation is necessary where peas have not been grown within the last five years.

Seeding Rate

Small seeded peas should be sown at 135 kg/ha, medium sized peas sown at 200 kg/ha and large seeded peas sown at 225 kg/ha.

Further details regarding production of field peas are included in *Growing Field Peas in the Atlantic Provinces*, Publication No. 120. For varieties, see Field Crop Guide to Variety and Pesticide Selection, Publication 100A.

Canola/Rapeseed

Canola/rapeseed is an oilseed crop. It is a crop that has potential in the Atlantic Region because it will tolerate acid soils, cool temperatures and requires only a short growing season to reach maturity. "Canola" is the term applied to modern varieties known as double low with 5 percent or less erucic acid and three milligrams per gram or less glucosinolates. The reduction of erucic acid makes the oil more acceptable for human consumption and the reduction in glucosinolates makes the meal more acceptable as an animal feed.

The seeding rate for rapeseed/canola is 6-8 kg/ha. Seed should be treated with an insecticide-fungicide combination to control flea beetles and seedling blight. Fertilizer application is similar to spring barley or sprint wheat, 300-500 kg/ha of 15-15-15 depending upon soil test. Canola/rapeseed is cross pollinated and requires bees to ensure pollination. The crop should be swathed or desiccated when half of the seeds in pods mid-way up the stem have turned brown, to ensure even maturity and to reduce shattering losses.

Canola/rapeseed is another potential source of home grown protein. Present feeding trials indicate low levels of unprocessed full fat canola can be included in the diets of cattle and swine. Tests are continuing to determine the upper limits of inclusions.

Buckwheat

Of the three types of buckwheat grown in the Atlantic Region, only the large seeded Japanese type is suited for the export market. The silverhull type has smaller, glossy, silver-gray seeds. The tartarian or rough type has small, pointed, dark seeds inside a rough hull. Tartarian buckwheat is more viney and less uniform ripening than the other types and is classified as a noxious weed in Western Canada. One of the main uses for buckwheat in the Region is as a green manure crop as it grows very quickly covering the soil surface. Before the crop or any weed escape go to seed, the crop can be plowed down adding organic matter to the soil as well as controlling of weeds.

Buckwheat can be sown when the deadline for seeding of oats or barley has passed. Highest yields are usually obtained if seeding is delayed until after the risk of late spring frost. Fertilize as for oats. Buckwheat must be pollinated by bees to produce satisfactory grain crops and is a good source

of dark honey. Buckwheat leaves remain green as the seeds mature. Wait for a killing frost and direct combine, or swath when a major portion of seeds are ripe and combine when the leaves dry. Once ripe, seed is lost by shattering and bird damage.

Additional information regarding culture of this crop is contained in *GROWING BUCKWHEAT* — Agriculture Canada Publication No. 1468.

HARVESTING AND STORAGE

Combining

Grain losses due to improper combine adjustment and operation have occasionally been found to be as high as one third of the total yield. Such losses were determined on the basis of actual combine yield before and after proper adjustment of the machines. Grain losses can be detected by examining the ground behind the combine, and by sampling the straw walkers and the sieves using a small window screen. This determines the location and extent of losses and the operator should then correct these losses. Losses occur with improper forward speed, resulting in either overloading or underloading the combine. Over threshing or under threshing causes problems in separation at the straw walkers or sieves. Correct cylinder and concave adjustments are very crucial. Grain loss monitors are available which indicate grain being lost over the straw walkers and cleaning sieves. The monitor must be calibrated properly.

Combines are designed to work on level ground. Sloping ground reduces the combine's cleaning and separating ability and increases losses significantly, especially during side-hill and up-hill operation. On sloping ground reduce forward speed to reduce losses.

REDUCING COMBINE LOSSES

1. Make sure the combine is maintained in good repair.
2. Adjust forward speed of combine so that the straw walkers are not under or overloaded. Travelling at seven kilometers per hour may increase grain loss several times over five kilometers per hour.
Combine capacity depends on the total threshing and separating area not the amount of crop that can be taken in the header.
3. Reduce speed by gearing down and not by reducing throttle. Full engine throttle must be checked each year with an accurate rpm meter to ensure correct beater shaft speed.
4. Adjust cylinder speed according to size of cylinder and toughness of grain. Use the higher speed for tough grain.
5. Operate cylinder and concave at peak efficiency, just below the level of seed breakage, especially for seed grains.
6. Check combine operation and adjustments frequently, since conditions change during the day and from field to field.
7. Consult and follow the Operators Manual for the specific combine model on which adjustments are being made.
8. Check all areas of the combine for leaks, especially the shaker pan under the concave behind the rock trap.
9. Use pickup reels on the header, to help pick up lodged grain, and adjust reel speed to that of forward speed.

SWATHING

Swathing will advance the grain harvest operation by about a week during dry weather, but in prolonged wet pe-

riods, swathed grain may be more susceptible to damage than a standing crop. Swathing aids timely harvest of barley varieties susceptible to excessive head loss when overmature. Swath when kernel moisture reaches 30 percent to minimize loss.

AERATION AND DRYING

Proper conditions for storage of grain are those that discourage or prevent the growth of microorganisms and which limit the normal respiration process. These conditions involve control of moisture content and temperature. Cereals to be stored as dry grain should not contain more than 14-15 percent moisture. When harvested at higher moisture levels, drying before storage is necessary. Heat generated by normal respiration raises the grain temperature. Microorganisms multiply rapidly in warm grain, causing a further increase in heat and mold growth. Insects may also attack stored grain and create heat. These problems are compounded by moisture migration in the bin. Storage of unclean grain aggravates the heating problem and hinders the movement of air through the grain mass.

Clean, dry and cool grain previous to storage, follow by adequate aeration during the storage period to minimize losses. Commercial steel bins are available which should be equipped with perforated floor fans, and heating units for proper drying and aeration.

In-bin drying can be accomplished using heated or unheated air. With unheated air, drying should not be attempted when grain moisture content is in excess of 17-18 percent. With in-bin drying, fans should be capable of moving air at 40 to 66 litres per second per cubic metre of grain against a pressure of 800 to 1000 pascals.

Late harvested grain containing from 16-18 percent moisture may be safely stored during the winter by cooling immediately to 7°C or lower and held at that temperature, blowing cold outside air through the grain.

Grain should be aerated at frequent intermittent times to ensure constant temperatures are maintained throughout the stored grain and that a temperature difference of 5°C is not exceeded between the grain and the outside air. A probe type thermometer is a valuable tool in periodically checking stored grain temperature. Fans for aerating need not have as large a capacity as those for drying. A fan with a capacity of 2-3 litres per second per cubic metre of grain operating against a pressure of 250 pascals is adequate for controlling temperature within the bin.

When drying cereal grain, temperatures must be carefully controlled especially for seed. Effects of high temperature are loss of germination, protein and vitamins and checking or cracking of kernels. Grain is most sensitive to high temperature when it is dampest. Careful temperature control must therefore be exercised during early stages of drying. The following table presents maximum kernel temperatures recommended during drying of seed and feed grain.

RECOMMENDED MAXIMUM KERNEL TEMPERATURES DURING DRYING

GRAIN	FOR SEED	FOR FEED
	°C	°C
Barley	41	82
Wheat	43	82
Oats	43	82
Rye	38	82
Shelled Corn	43	82

NOTE: Obtain a copy of Grain Drying, Agriculture Canada Publication No. 1497; and Manitoba Agriculture Publication "Movement of Natural Air Through Grain", available from the Agricultural Representative Office.

HAYLAGE

Haylage (low moisture field dried silage), and silage (direct cut), are systems of harvesting, conserving, storing, and feeding forage. Each component of the system must be chosen to fit with the rest of the system and the forage crop used.

A silage system has advantages that must be considered for each farm. Because the forage is harvested in a moist state, leaf loss and weather damage are reduced but transport costs per tonne of dry matter are high. Production, storage, and feeding areas must be close together as long hauls of silage are expensive. Silage can be highly mechanized which speeds harvest and reduces labour cost but has a high initial cost.

Forage crops can be cut and ensiled at an immature stage to give a high quality forage. Feed value will be maintained in a well managed silo but poor management can result in high losses in the silo, and secondary losses at feedout can be a problem if daily feed removal is insufficient.

Silage must be considered as a system where each component is chosen to fit the rest of the system. The crop to be harvested, type of land, equipment available and required, availability and cost of labour, type of silo, type and quality of feed required, and amount of feed used daily must be considered when choosing a silage system.

ENSILING PROCESS

Silage is fresh (direct-cut) or wilted forage material that is preserved by bacterial fermentation that produces acetic and lactic acid. After the crop is cut and put in the silo, the living plant cells continue to respire. The respiration uses the entrapped oxygen while producing carbon dioxide, water, and heat. With proper management, the entrapped air will be used up in approximately 48 hours. Once the trapped air has been used, and there is no oxygen available, anaerobic fermentation by bacteria will begin. The bacteria produce lactic acid which lowers the pH. When the forage is sufficiently acidic (usually at a pH of 3.5 to 4.5), bacterial action stops and the ensilage process is complete. At this stage, the material is preserved or pickled, and if the structure is air tight, should remain so for several years.

Several management factors can affect the efficiency of the ensiling process.

Stage of Maturity. Ensiling will not improve the quality of the crop. The crop must be properly fertilized and harvested at the correct stage of growth. Generally, early cut forages ensile better as they have higher levels of soluble carbohydrate which are used by the micro-organisms.

Moisture content. The optimum range for making silage is 30 to 40% dry matter. For low moisture silage (haylage), the optimum range is 40 to 55% dry matter. If the dry matter is less than 30%, nutrients will be lost to seepage and poor fermentation. Formation of butyric acid and ammonia result in bad odours and reduced palatability in silage that is too wet to ensile properly.

Silage that is over dry at harvest does not pack well or evenly in the silo. This traps excessive air in the silo and results in a slow ensiling process which allows damaging yeasts and moulds to grow on the silage and causes heat damage to protein.

Chop length. The ideal length of cut is approximately 3/4 to 1 1/2 cm. Forage cut to this length: 1) is more easily handled by silage and feeding equipment, 2) has more even distribution and better compaction in the silo which leads to better fermentation and reduces losses to air, 3) allows greater amount to be stored in a silo and 4) mixes easier with other feed ingredients.

OPTIMUM MOISTURE LEVELS FOR ENSILING CROPS

Crop	Moisture Levels
Grasses	Cut at pre heading stage; field wilt to 30-40% dry matter (for low-moisture silage in air-tight structures, wilt to 40-55%)
Legumes	Harvest at bud to late bud (full bud) stage; maybe wilted to 40-55% for low moisture air-tight silo storage
Corn (whole plant silage)	Harvest when kernels are in the late dent stage (generally when half leaves and all husks are brown), at a kernel moisture level of about 60%; for conventional tower silo storage 60-65% kernel moisture is ideal
Ear corn	For ground ear corn, 25-35% moisture in the kernel; for whole grain, 25-32%; 25% moisture is ideal
Small grain	Harvest at heading to milk stage of maturity and wilt to about 35-40% dry matter
Source:	The National Silo Association, Operator's Manual, Waterloo, Iowa, 1977.

SILO FILLERS RULES

1. FILL THE SILO QUICKLY.
2. PACK THE SILAGE WELL.
3. SEAL THE SILO TIGHTLY.
4. BEWARE OF SILO GAS.

HIGH MOISTURE CORN

Silos must be well maintained to store high moisture corn. Any air leak will allow moulds to grow on the corn. Oxygen limiting silos should be checked for leaks and all doors kept tightly sealed when not in use. Conventional silos must be free from cracks with tight fitting doors. The top surface of the corn should be sealed with plastic when grain is not being fed. High moisture grain spoils quickly when removed from the silo and must be fed within a few hours of removal.

Whole kernel corn. As whole kernel corn does not pack well in the silo, it is most easily stored in an oxygen limiting silo.

Ground shelled corn. Ground shelled corn is a good choice if corn is to be stored in a conventional silo. Corn should be ground so that every kernel is cracked into three to five pieces. This ensures that corn will pack better in the silo and increases the number of tonnes a silo will hold. As whole kernel corn must be cracked or rolled before feeding, placing the grinder before the silo makes feeding easier.

Ground ear corn. The ear must be ground so that most of the kernels are cracked and no piece of cob is larger than 2 cm. The finer the corn is ground, the better it packs in the silo, but over grinding can adversely affect animal performance. Grinding can be done using recutter screens in the harvester or blower or by using a separate machine such as a hammer mill. Grinding the corn is often the slowest process in harvesting and storing ground ear corn. Select your harvest system with this in mind.

Acid. Treating corn with organic acids preserves the corn in much the same fashion as ensiling. Addition of acid to corn immediately lowers the pH which prevents growth of moulds. Acid treatment is beneficial as there are no dry matter losses due to the ensiling process, and allows storage of grain anywhere provided the grain is protected from moisture. **AIR-TIGHT STORAGE IS NOT NECESSARY**, but walls and floors of the storage structure should be covered with plastic. Preserving acids are corrosive, which can damage application equipment and pose a hazard to the person applying the acid. If there is a long term commitment to high moisture corn, a silage system should be seriously considered.

Recommended Moisture
Range of the Kernel
25-30
25-30
22-30 in oxygen limiting
24-30
Follow manufacturers
recommendation

High Moisture Grain Corn
Ground Whole Ear Corn
Whole Kernel Shelled Corn
Ground Shelled Corn
Acid Treatment

Silage Additives and Preservatives

Silage additives are used to improve the ensiling process, the preservation, or the feeding value of the forage. If a crop is harvested at the correct stage, and stored in a correctly built and maintained structure, additives are of little value.

Silage additives are not a substitute for a correctly managed harvest of crops at the correct stage of growth.

Silage Additives and Preservatives

Molasses	High in sugars, improve silage preservation, palatability and nutritive value.
Corn, barley, oats, other feed ingredients	Decreases moisture content and seepage; provides additional carbohydrates from which acids may be produced. Disadvantage is the amount needed and the labour required to mix and handle.
Bacterial Cultures	Increase number of lactic acid producing bacteria
Organic Acids	Restrict undesirable bacteria and fungi by lowering pH. Highly acidic to equipment and workers.
Enzymes	May increase fermentation or digestibility
Urea, ammonia	Added to improve "protein" content of low protein crops such as corn silage
Salt	At certain levels, inhibits certain micro-organisms while allowing acid producing bacteria to continue.

DANGER: SILO GAS IS INVISIBLE AND LETHAL.

Silo gas

Silo gas is a combination of several gasses produced during the ensiling process. These gases will remain in the silo and pose a hazard to humans and livestock for at least three weeks after filling. Silo gas is heavier than air and will "flow" down silo chutes and settle in low areas. To prevent any danger of silo gas poisoning when filling the silo, always keep doors between the feed room and the barn closed and leave feed room doors to the outside open. If you must enter the silo during the danger period, ventilate the silo with the silo blower for at least thirty minutes before entering and keep the blower going while in the silo. When entering the silo, tie a rope around your waist and have two people standing by (outside silo) to pull you out.

Size of Silo

The size of the silo is determined by the amount of storage required, the speed with which the silo can be filled, and rate at which the silage will be removed. To prevent spoilage in tower silos, silage should be removed at 10 cm per day. During hot weather, plan to remove 20 cm per day.

IN CASE OF EMERGENCY: (Eg. Person overcome by silo gas)

1. DO NOT ENTER SILO WITHOUT A SELF-CONTAINED BREATHING APPARATUS (Eg. Air Tank).
2. ATTEMPT TO VENTILATE THE SILO IF THIS CAN BE DONE QUICKLY.
3. APPLY FIRST-AID AND GET VICTIM TO A DOCTOR AS SOON AS POSSIBLE. (SPECIFY SILO GAS POISONING.)

EXPECTED DRY MATTER LOSSES IN HARVESTING AND STORING CORN AND HAY CROP SILAGE

	Dry Matter Losses		
	Harvest	Storage	Total
Corn Silage			
30% or less D.M.	4.0	13.4	17.4
31-40% D.M.	5.0	6.3	11.3
Over 40% D.M.	16.2	6.3*	22.5*
Hay Crop Silage			
30% or less D.M.	2.0	21.2	23.2
31-40%	5.0	10.1	15.1
Over 40% D.M.	11.5	8.2	19.7

*estimated values.

Source: Penn State Univ. Circular 223 Silos and Silage

CONCRETE TOWER SILO CAPACITY FOR HIGH MOISTURE CORN

Silo Diameter (metres)	X	Settled Depth (feet)	Whole Shelled Corn			Ground Shelled Corn			Ground Ear Corn			
			25%*	30%	35%	25%	30%	35%	30%	35%	40%	
4.9 x 15.2		16 x 50	227	249	275	238	267	301	205	237	276	16 x 50
4.9 x 18.3		16 x 60	274	301	333	288	323	365	249	287	335	16 x 60
4.9 x 19.8		16 x 65	298	327	362	313	351	397	271	313	365	16 x 365
5.5 x 15.2		18 x 50	289	318	351	303	340	384	263	303	353	18 x 50
5.5 x 18.3		18 x 60	350	384	425	367	412	466	318	368	429	18 x 60
5.5 x 21.3		18 x 70	410	451	499	431	484	547	374	434	506	18 x 70
6.1 x 18.3		20 x 60	434	477	528	456	512	579	396	459	535	20 x 60
6.1 x 21.3		20 x 70	510	561	620	536	602	680	466	541	631	20 x 70
6.1 x 24.4		20 x 80	585	644	713	616	692	782	536	622	727	20 x 80
7.3 x 18.3		24 x 60	632	694	768	663	745	841	578	670	781	24 x 60
7.3 x 21.3		24 x 70	742	816	902	780	876	989	681	770	992	24 x 70
7.3 x 24.4		24 x 80	852	938	1037	896	1007	1132	784	910	1063	24 x 80
7.3 x 27.4		24 x 90	963	1059	1172	1012	1138	1285	887	1030	1204	24 x 90
9.1 x 24.4		30 x 80	1346	1480	1637	1413	1587	1791	1242	1442	1681	30 x 80
9.1 x 27.4		30 x 90	1521	1673	1851	1597	1794	2025	1405	1633	1905	30 x 90
9.1 x 30.5		30 x 100	1697	1867	2064	1781	2001	2258	1569	1824	2128	30 x 100
9.1 x 33.5		30 x 110	1872	2060	2278	1965	2208	2592	1734	2016	2352	30 x 110

1 tonne = 1000 kg = 2200 lb. = 1.1 ton

*Percent moisture.

SOURCE: OMAF Factsheet 100/732 Tower Silo Capacities.

CONCRETE TOWER SILAGE CAPACITY FOR HAYLAGE AND SILAGE

Diameter Silo (meters)	X	Settled Depth (feet)	Alfalfa Haylage				Corn Silage		
			60%*	50%	40%	30%	35%	30%	
4.9 x 15.2		16 x 50	109	137	181	261	191	224	16 x 50
4.9 x 18.3		16 x 60	135	169	224	323	235	275	16 x 60
4.9 x 19.8		16 x 65	147	185	245	354	258	300	16 x 65
5.5 x 15.2		18 x 50	142	178	236	339	247	288	18 x 50
5.5 x 18.3		18 x 60	176	221	293	421	304	353	18 x 60
5.5 x 21.3		18 x 70	211	264	351	504	361	419	18 x 70
6.1 x 18.3		20 x 60	224	281	372	533	381	442	20 x 60
6.1 x 21.3		20 x 70	268	337	446	639	453	524	20 x 70
6.1 x 24.4		20 x 80	314	394	522	746	526	607	20 x 80
7.3 x 18.3		24 x 60	338	423	559	796	560	647	24 x 60
7.3 x 21.3		24 x 70	407	511	674	956	667	767	24 x 70
7.3 x 24.4		24 x 80	479	600	790	118	773	888	24 x 80
7.3 x 27.4		24 x 90	551	690	908	1281	880	1009	24 x 90
9.1 x 24.4		30 x 80	796	993	1297	1813	1343	1480	30 x 80
9.1 x 27.4		30 x 90	920	1146	1494	2079	1547	1706	30 x 90
9.1 x 30.5		30 x 100	1046	1301	1692	2346	1754	1934	30 x 100
9.1 x 33.5		30 x 110	1173	1457	1891	2614	1962	2165	30 x 110

1 tonne = 1000 kg = 2200 lb. = 1.1 ton

*Percent dry matter.

Capacities for grass silage may be estimated by increasing the alfalfa haylage by 10, 15 and 20% for the dry matter contents of 50, 40 and 30% respectively.

Source: OMAF Factsheet 100/732 Tower Silo Capacities.

HAYLAGE

HORIZONTAL SILO CAPACITIES

Width (m)	Tonnes of Dry Matter per Meter Length		
		Height (m)	
	2.5	3.0	3.5
5	2.4	2.8	3.3
6	2.3	3.4	4.0
7	3.5	4.1	4.7
8	4.0	4.7	5.5
9	4.6	5.5	6.2
10	5.2	6.0	7.0
12	6.5	7.5	8.6
14	7.8	9.0	10.3
16	9.2	10.6	12.0
18	10.7	12.3	13.9
20	12.2	14.0	15.8

Use of Table

Silage to be stored 500 tonnes at 35% dry matter

$$= 500 \times \frac{35}{100} = 175 \text{ tonnes of dry matter}$$

$$\text{Length of } 9 \times 3 \text{ meter silo} = \frac{175}{7.5} (\text{see table}) = 23.3 \text{ meters}$$

or

$$\text{Length of a } 9 \times 2.5 \text{ meter silo} = \frac{175}{4.6} (\text{see table}) = 38.0 \text{ meters}$$

Source: Forage Handling Systems for Grass and Legumes.

1 meter = 3.28 feet.

GENERAL INFORMATION ON USE OF PESTICIDES

All pesticides are poisonous to some degree. Because of their toxic effects, they should be treated with great care. Every chemical pesticide has the potential to cause serious illness if handled improperly.

A great proportion of the accidents involving chemical pesticides result when the user has ignored the warnings on the container label. Detailed directions, recommendations, and warnings are provided, by law, on the container label of commercial products.

For your own safety: *Always read and follow the directions, conditions, and limitations described on the label. If the label is damaged and illegible, do not use the product.*

Different companies often use different brand names for the same pesticide (Sencor and Lexone are brand names of commercial products containing metribuzin). However, different brands may have different concentrations of active chemical in them. Care should be taken to assure that the amount of commercial product used will provide the correct amount of active material. The amount of commercial product required will vary depending on the amount of active material to be applied and the formulation (concentration) of the commercial product. The Table below may be used as a guide to determine the amount of commercial product required to obtain a given rate of active material.

Calibrate your sprayer at least twice during the growing season. The wear on nozzles and other parts will alter the amount of spray delivered at the usual rate of speed and pressure.

PESTICIDE DILUTION*

Pesticide formulation	Desired rate of ACTIVE material (kg/ha)				
	0.25	0.5	0.75**	1.0	2.0
WP					
Amount of formulation required/ha					
----- kilograms (kg) -----					
(wetttable powder)					
25%	1.0	2.0	3.0	4.0	8.0
50%**	0.5	1.0	1.5**	2.0	4.0
80%	0.31	0.63	0.94	1.25	2.5
Active/litre					
----- litres -----					
250 g	1.0	2.0	3.0	4.0	8.0
500 g	0.5	1.0	1.5	2.0	4.0
1000 g	0.25	0.5	0.75	1.0	2.0

*To be used as a guide only. Consult the product label for exact rates. Appropriate English units may be substituted (see page 46).

**For example: If you required 0.75 kg active/ha (2/3 lb active/ac) and the pesticide chemical is a 50% WP (wetttable powder) then you would apply the formulation (product) at 1.5 kg/ha (1 1/3 lb/ac) in order to apply the recommended rate of active material.

Disposal of unused (still in the container) and excess (already mixed, but not needed) pesticides is a critical problem, particularly if you have a large amount of unwanted chemical. At present, there is no simple solution to this problem.

The best precaution against pesticide disposal problems is good planning. Pesticide users should prepare only sufficient spray mixture to serve a specific purpose. Unused spray

mixture should be disposed of safely. Pesticides must never be disposed of in waterways, sewers, ditches, or on land subject to flooding.

RESIDUES ON CROPS TO BE HARVESTED OR FED OR GRAZED

Certain pesticide residues disappear quickly after application; others persist in poisonous form for much longer periods. When crops with residues of certain pesticides are fed to livestock, the poisons accumulate in the body first. Milking cows secrete these poisons in the milk. Young calves, heifers and dry cows store these in body fat and secrete them when they freshen months later. Even the use of bedding from treated grain crops can kill livestock.

Never apply any pesticides or allow sprays to drift to forage, hay or other feed that is to be fed to livestock unless they are specifically recommended. If hay, corn stover, pea vines, bean straw, sugar beet tops, etc., are purchased, check on the possibility of their having been sprayed.

When using pesticides, adhere to the waiting period indicated before pasturing, feeding, or harvesting.

PESTICIDE STORAGE

Pesticides should be stored in their original containers with labels in place — never in food or beverage containers. They should be kept in a dry place (wall cupboards, etc.) which is kept locked when the products are not being used. Never leave open packages or tins of pesticides around while you are spraying elsewhere.

SAFE DISPOSAL OF PESTICIDE CONTAINERS

Proper disposal of the empty containers prevents hazard to man and the environment from chemical residues, and eliminates litter. It is in the user's best interest that careful procedures for empty pesticide container disposal be carried out.

Underground disposal is the safest means of handling empty pesticide containers. This procedure should involve triple-rinsing and puncturing before actual burial.

Triple-rinse

After the container has been emptied, rinse three times and pour the rinsings into the spray tank as part of the make-up water. This ensures that farmers get full use of all the chemical they purchase.

Puncture

Puncture or crush the container after rinsing to prevent it from being reused for purposes that might expose humans or animals to a chemical hazard.

Bury

Bury container in an area well removed from any watercourse and cover it by at least 50 cm of soil. This allows biodegradation of any possible residues which may remain, and avoids hazard and litter.

It is the responsibility of the pesticides user to carry out these procedures. Each farm property should include an appropriate disposal site.

In some circumstances it may become necessary for the empty containers to be taken to local garbage disposal facilities.

ADDITIONAL PROCEDURES FOR SAFE DISPOSAL

Empty combustible containers (paper bags, cardboard boxes, and plastic containers) may be burned if great care is taken. Stand upwind of the fire, and away from the path of smoke and gases. Be sure that smoke and fumes will not drift to nearby homes, people, livestock or crops and carefully bury all the ashes.

RULES FOR CHEMICAL PESTICIDE SAFETY

Treat all pesticide (insecticides, herbicides, fungicides, etc.) as poisonous substances and handle them with great caution. They can kill.

1. Read each pesticide label carefully and follow the instructions. The instructions on a pesticide label serve to safeguard the health of the user as well as to ensure the pesticide is employed as efficiently and economically as possible. When in doubt, read the label.
2. Always wear the recommended protective clothing and safety equipment. Pesticides may enter the user's body through the skin, the mouth or by inhalation. The protective equipment worn by the conscientious pesticide applicator includes a respirator or gas mask, a wide-brimmed hat, goggles, a shirt with long sleeves over neoprene or rubber gloves, overalls with rubber bands around the cuff, and neoprene or rubber boots. Because fumigants are readily absorbed by neoprene, be sure to follow label instructions.
Don't follow someone else's bad example. Wear the required safety equipment. It's for your own good.
3. Open, pour, weigh and mix pesticides in a safe manner and according to label instructions. Use the proper tools to open a container. Stand upwind of all opening, pouring, and mixing operations, and in a well-ventilated area. Avoid splashing and spilling.
4. Learn to recognize the typical signs of poisoning and the correct first aid procedures. Keep a first aid kit handy. Some symptoms of acute poisoning are nausea, diarrhea, loss of muscle coordination, stomach cramps, mental confusion, etc.
5. If you feel ill during pesticide application, stop work and seek medical attention at once. Do not carry on because of the work schedule. Always save the pesticide container or the label to assist the medical aid person.
6. Do not permit any person including yourself, to work alone when handling or applying pesticides.
7. Never use your mouth to siphon liquid materials or to blow out a clogged spray nozzle.
8. Keep people and animals away from contaminated equipment and areas until decontamination procedures are complete.
9. Be sure a good supply of lime, sawdust, or other absorbent is available on site to soak up a spilled pesticide.
10. Do not permit anyone unfamiliar with chemical safety practices to carry out cleaning or maintenance procedures. Appropriate protective equipment is necessary for cleaning and maintenance personnel.
11. Always dispose of irreparable faulty protective equipment and contaminated clothing.
12. Do not store pesticides near any food or drink. Store them in a locked, well-marked area and out of the reach of children.
13. Do not keep any food, drink, tobacco, cups or cutlery anywhere in the work areas or work clothes. Refrain from smoking, eating, or drinking while mixing or applying pesticides.
14. Dispose of empty containers by crushing and puncturing and burying in at least 50 cm of soil at a recommended site or on your own property away from watercourses, crops, animals, or human habitation. Recycle 200 L drums if possible. Small pesticide containers should be thoroughly rinsed at least three times with the rinsings being added to the spray mix.
15. After handling pesticides, wash hands carefully before eating, drinking, smoking, or using the toilet.
16. Shower thoroughly, with special attention to hair and fingernails, after each pesticide application is complete. Change clothes daily or more often if any contamination occurs. Wash contaminated clothing separately from normal laundry.
17. Before mixing and applying pesticides, clear all livestock, pets and people from the area to be treated. Apply pesticides only at the correct time and under acceptable weather conditions.
18. Check the application equipment. Look for leaking hoses, or connections, plugged or worn nozzles, and examine the seals on the filter openings to make sure they will prevent pesticide spillage.
19. Mix the pesticide at the recommended rate, and apply at the specific dosage on the label. Carry only a sufficient quantity of the pesticide for the job at hand.

POISON INFORMATION CENTRES

The hospitals listed below are equipped and staffed 24 hours a day to provide emergency information on potentially toxic substances and to recommend and give treatment.

Newfoundland

Labrador City	— Capt. Wm. Jackman Memorial Hospital 944-2632
Cornerbrook	— Western Memorial Hospital 634-5101
Gander	— James Paton Memorial Hospital 256-3961
Grand Falls	— Central Newfoundland Hospital 489-2123
St. Anthony	— Charles S. Curtis Memorial Hospital, St. Anthony 8881
St. John's	— The Dr. Charles A. Janeway Child Health Centre 722-5100

Prince Edward Island

Charlottetown — Queen Elizabeth Hospital 566-6250
Montague — Kings County Memorial Hospital
838-2152
Summerside — Prince County Hospital 436-9131

Nova Scotia

Halifax — The Izaak Walton Killam Hospital for
Children 424-6161

New Brunswick

Campbellton — Hotel-Dieu Hospital de St. Joseph
753-3301
Fredericton — Dr. Everett Chalmers Hospital
452-5400
Moncton — Moncton Hospital 855-1600
Saint John — Saint John General Hospital 658-2222
Edmundston — Hotel-Dieu de St. Joseph 753-3361
Bathurst — Chaleur General Hospital 546-4466

THE METRIC SYSTEM

Linear Measures (length)

10 millimetres (mm) = 1 centimetre (cm)
 100 centimetre (cm) = 1 metre (m)
 1000 metres = 1 kilometre (km)

Square Measures (area)

100 m × 100 m = 10,000 m² = 1 hectare (ha)
 100 ha = 1 square kilometre (km²)

Cubic Measures (volume)

1000 millilitres (mL) = 1 litre (L)
 100 L = 1 hectolitre (hL)

Weight Measures

1000 milligrams (mg) = 1 gram (g)
 1000 g = 1 kilogram (kg)
 1000 kg = 1 tonne (t)
 1 mg/kg = 1 part per million (ppm)

Dry — Liquid Equivalents

1 cm³ = 1 mL
 1 m³ = 1000 L

Area

square inch = 6.45 cm² cm² = 0.16 sq in.
 square foot = 0.09 m² m² = 1.20 sq yd
 square yard = 0.84 m² km² = 0.39 sq mile
 square mile = 2.59 km² ha = 2.47 acres
 acre = 0.40 ha

Weight

ounce = 28.35 g gram = 0.035 oz
 pound = 453.6 g kilogram = 2.20 lb
 ton = 0.91 tonne tonne = 2205 lb

Volume (dry)

cubic inch = 16.38 cm³ cm³ = 0.06 cu in.
 cubic foot = 0.028 m³ m³ = 35.32 cu ft
 cubic yard = 0.76 m³ m³ = 1.31 cu yd
 bushel = 36.37 litres
 board foot = 0.0024 m³

Volume (liquid)

fluid ounce = 28.41 ml litre = 35.2 fluid oz (Imp)
 (Imp)
 pint (Imp) = 0.57 litre hectolitre = 26.42 gal (US)
 gallon (Imp) = 4.55 litres hectolitre = 22.00 gal (Imp)

Pressure

pound per square inch × 6.9 kilopascals (kPa)

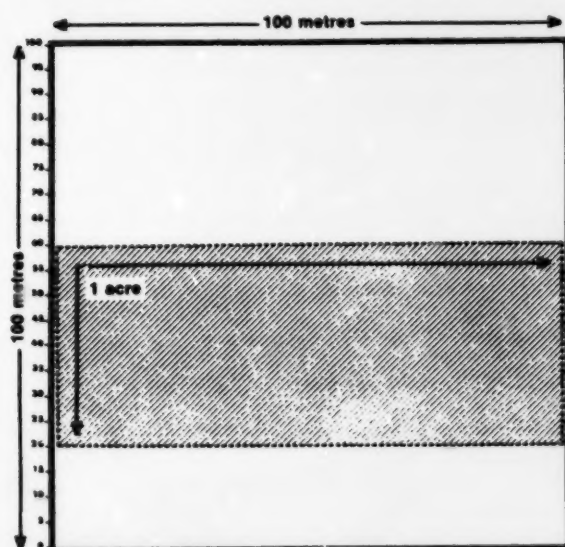
Proportion — Application Rate Conversions

fluid ounce × 70 millilitres per hectare
 per acre (ml/ha)
 gallon per acre × 11.2 litres per hectare (l/ha)
 pound per acre × 1.12 kilograms per hectare
 (kg/ha)
 ton per acre × 2.24 tonnes per hectare (t/ha)
 plants per acre × 2.47 plants per hectare
 (plants/ha)

METRIC ABBREVIATIONS

gram	= g	metre	= m
kilogram	= kg	kilometre	= km
hectare	= ha	centimetre	= cm
litre	= l	millimetre	= mm
millilitre	= ml		
hectolitre	= hl		

HECTARE — ACRE PERSPECTIVE



100 m × 100 m = 10,000 m² = 1 hectare (ha)

1 litre/ha = 14.24 fluid oz/acre
 1 kg/ha = 14.5 oz/acre
 1 metric tonne/ha = 0.45 ton/acre
 1 kilopascal = 0.145 lb/sq in.

METRIC EQUIVALENTS

Length

inch	= 2.54 cm	millimetre	= 0.04 in.
foot	= 0.30 cm	centimetre	= 0.39 in.
yard	= 0.91 m	metre	= 3.28 ft
mile	= 1.61 km	kilometre	= 0.62 mile

VALUE OF MANURES

AVERAGE AMOUNTS OF NITROGEN, PHOSPHORUS, AND POTASSIUM OF MANURES FROM DIFFERENT FARM ANIMALS.

Kind of manure	Percent water (%)	kg per tonne of manure*		
		N	P ₂ O ₅	K ₂ O
CHICKEN —				
a. From dropping boards without litter	54	15.5	9.0	4.0
b. With old floor litter**	61	17.0	14.0	7.5
DAIRY CATTLE	79	5.5	2.5	6.0
FATTENING CATTLE	80	7.0	4.5	5.5
HOGS	75	5.0	3.5	5.0
HORSES	60	7.0	2.5	7.0
SHEEP	65	14.0	4.5	12.0

*kg/tonne × 2 = lb/ton.

**Probably contained some feed residues.

SOURCE: Michigan State University Circular Bulletin 231, ANIMAL MANURES.

ESTIMATED REMOVAL OF PLANT NUTRIENTS BY VARIOUS CROPS

CROP	D.M. YIELD (t/ha)	Kilograms per hectare				
		Nitrogen N	Phosphorus P ₂ O ₅	Potassium K ₂ O	Calcium Ca	Magnesium Mg
Oat Grain	3.1	56	22	17	3	4
Oat straw	4.5	28	11	67	9	10
Barley grain	3.2	56	28	17	2	3
Barley straw	3.4	22	11	50	13	3
Wheat grain	2.7	56	28	17	1	7
Wheat straw	3.4	22	5	39	7	3
Corn silage	12.3	112	56	151	12	21
Alfalfa hay	8.9	213	50	275	132	27
Timothy hay	8.9	151	39	163	20	11
Red Clover hay	8.9	168	39	179	121	29

SEEDING RATES FOR MISCELLANEOUS CROPS

Crop	Seeding Rates kg/ha
Field Peas	134
Fababeans	168
Buckwheat	56
Millet	20
Sorghum	13
Fall Turnips (Rutabagas)	1
Sunflowers	7

SEEDS PER UNIT OF FORAGE SPECIES

Crop	Seeds per kg
Alfalfa	440,000
Red Clover	605,000
White Clover	1,760,000
Bird's foot Trefoil	935,000
Sweet Clover	572,000
Alsike	1,540,000
Timothy	2,706,000
Orchard Grass	1,439,000
Brome grass	300,000
Meadow & Tall Fescue	506,000
Perennial Rye Grass	500,000
Reed Canary Grass	1,173,000
Bluegrass	4,790,000

MACHINE CALIBRATIONS

The calibrations below are presented in metric units. Appropriate English units may be substituted directly (see page 47).

A. Broadcast Seeders

1. Fill hopper with seed.
2. Set rheostat to give desired swath width. Adjust machine control setting to approximately the desired application rate. Make certain machine is functioning properly.
3. Refill hopper and mark level of seed on a measuring stick.
4. Run seeder for 5 minutes.
5. Refill hopper to its original level, weighing amount of seed required to do this.
6. Divide the amount of seed broadcast in 5 minutes by five, to obtain output of seeder at the particular setting in kg per minute.
7. The application rate in KILOGRAMS PER HECTARE is then:

$$\frac{\text{Seeder output (in kg/min)} \times 600^*}{\text{Swath width (in metres)} \times \text{km/ha}}$$

*the number 600 is a constant obtained by multiplying the number of square metres in a hectare by the number of minutes in an hour and dividing by the number of metres in a kilometre, i.e., $10,000 \times 60 \div 1,000 = 6000$. This constant is 495 if English units are used.

B. Full Width Machines (Grain Drills and Fertilizer Spreaders)

1. Choose a machine control setting that seems close to the application rate desired. Make certain the machine is functioning properly.
2. Jack machine up so that the drive wheel or wheels can be turned.
3. Partially fill hopper with seed.
4. After setting the machine control, turn the drive wheel or wheels 10 times.
5. Collect and weigh the grain delivered during the 10 wheel turns.
6. The application rate in KILOGRAMS PER HECTARE is then:

$$\frac{\text{Kilograms collected} \times 31,831^*}{\text{Wheel diameter (cm)} \times \text{Machine width (m)} \text{ (metres)}}$$

*The number 31,831 is a constant obtained by multiplying the number of square metres in a hectare by the number of centimetres in a metre and dividing by 10 (the number of wheel turns) multiplied by (3.1416), i.e., $(10,000 \times 100) \div (10 \times 3.1416) = 31,831$. This constant is 16640 if English units are used.

C. Sprayers

1. Set out two stakes 100 metres apart.
2. Pick a level spot and fill sprayer tank with water. Operate sprayer to be sure the supply line up to the shut-off valve is full before finally filling the tank. RECORD THE WATER ON A MEASURING STICK.
3. Spray between stakes IN BOTH DIRECTIONS at a DEFINITE SPEED AND PUMP PRESSURE. Turn boom on as first stake is passed in each direction. The by-pass pressure relief valve must be set to give the desired pressure when the shut-off valve is open. MARK THE THROTTLE SETTING.
4. Return sprayer to same location as before the calibration run. Carefully measure amount of water required to refill tank to the same mark on the measuring stick.
5. Calculate the application rate in LITRES PER HECTARE.

$$\text{Litres per hectare} = \frac{\text{Litres of water added} \times 50^*}{\text{Boom length in metres}}$$

*The number 50 is a constant obtained by dividing the number of square metres in a hectare by the distance travelled, i.e., $10,000 \div 200 = 50$. The constant is 66 if English units are used.

Sample Calculation: (1) Overall Spraying. If the sprayer has an 8-metre long boom and 55 litres of water are required to refill tank, application rate is:

$$55 \times 50 \div 8 = 344 \text{ litres per hectare}$$

Sample Calculation: (2) Band Spraying. If the sprayer has four nozzles and each nozzle covers a 35-cm bank, the total width of the spray patterns (boom length) is:

$$4 \times 35 = 140 \text{ cm or } 1.4 \text{ metres}$$

If 9 litres of water are required to refill the tank, the application rate is:

$$9 \times 50 \div 1.4 = 321 \text{ litres/ha}$$

NOTE: When band spraying, the area actually sprayed is NOT the same as the crop area.

CALIBRATION BOTTLES

Sprayer calibration bottles are available to measure the output of one nozzle in a measured period. The bottle can also be used to check that all nozzles are spraying at the same rate. Sprayer calibration bottles are available from spray retailers.

COUNTY AND DISTRICT OFFICES OF THE DEPARTMENTS OF AGRICULTURE OF THE ATLANTIC PROVINCES

New Brunswick

REGION	OFFICES	PHONE	SPECIALIST	PROVINCIAL SPECIALISTS
NORTHWEST	BOX 5001 GRAND FALLS E0J 1M0	473-5515	Grand Falls 473-5515	P.O. Box 6000 Fredericton, N.B. E3B 5H1
	Box 428 Saint Quentin E0K 1J0	235-2683		Plant Industry Branch
	121 Church St. Edmundston E3V 1J9	739-9545		Forage Crops 453-2172 Cereal Crops 453-2172
				Insects 453-2108 Diseases 453-2108 Weeds 453-2108 Soil - Fertility 453-2109 - Management 453-2109 - Laboratory 453-2109
NORTHEAST	1425 STREET, BATHURST E2A 1S7	548-4501	Bathurst 548-4501	Market Development Branch Market Development Officer 453-2214
	Box 1148, Dalhousie E0K 1B0	684-4253		Grain Commission General Manager 453-2185
WESTERN	WICKLOW, RR #2, FLORENCEVILLE E0J 1K0	392-6007	Wicklow 392-6007	Agricultural Engineering Branch Engineering 453-2691
	Perth-Andover Box 68 E0J 1V0	273-2269		Livestock and Poultry Branch Livestock Nutritionist 453-2483
	Woodstock Box 1600 E0J 2B0	328-9963		
MIRAMICHI	337 Water Street, CHATHAM E1N 1B2	773-7091		
SOUTHWEST	BOX 5001, SUSSEX E0E 1P0	433-3073	Sussex 433-3073	
	Box 6000, Fredericton E3B 5H1	453-3627		
	St. Stephen E3L 2X4	466-3073		
SOUTHEAST	MONCTON, BOX 5001 E1C 8R3	858-2552		
	Richibucto, Box 5001 E0A 2M0	523-9796		
	Middle Sackville E0E 1E0	536-0972		

Prince Edward Island

District	Agricultural Representatives	Telephone	Specialist	Telephone
West Prince	West Prince Regional Services Centre P.O. Box 8, O'Leary C0B 1V0	859-2400	Crops Specialist Agricultural Research and Extension Bldg P.O. Box 1600 Charlottetown	892-5465
Summerside	East Prince Regional Services Centre 109 Water Street, P.O. Box 2063 Summerside C1N 5L2	436-9248		
Charlottetown	Agricultural Research and Extension Building, P.O. Box 1600, Charlottetown C1A 7N3	892-5465		
Montague	Southern Kings Regional Services Centre, P.O. Box 1500, Montague C0A 1R0	838-2992		
Souris	Eastern Rings Regional Services Centre P.O. Box 550, Souris C0A 2B0	687-3022		

NEWFOUNDLAND

District	Agricultural Unit Managers	Telephone	Specialists
Eastern Region	P.O. Box 4750, St. John's, A1C 5T7	364-4210	Crop Specialist Provincial Bldg
	P.O. Box 569, Hr. Grace A0A 2M0	596-5040	Brookfield Road P.O. Box 4750
	P.O. Box 569, Clarenville A0E 1J0	466-2558	St. John's, NF A1C 5T7
			737-3840
Central Region	P.O. Box 352, Gander A1V 1W7	256-3024	737-2639
	P.O. Box 640, Bishop's Falls A0H 1C0	258-5334	Crop Specialist P.O. Box 640
Western Region	McKays (via Cartville) A0N 1G0	645-2850	Bishop's Falls A0H 1C0
	P.O. Box 340, Pasadena A0L 1K0	686-2672	258-5334
	P.O. Box 2006, Corner Brook A2H 6J6	639-9111	Crop Specialist P.O. 340
			Pasadena
Labrador	Postal Station "B", Goose Bay, A0P 1E0	896-2400	A0L 1K0 686-2596

NOVA SCOTIA

County	Agricultural Representatives	Telephone	Specialists	Telephone
Antigonish	11 James St., Antigonish, B2G 1R6	863-4705	Regional Soil & Crop	895-1571
		863-4706	Specialist	
Cape Breton	Provincial Building, Sydney, B1P 5L1	539-5500	P.O. Box 550, Truro	
Colchester	P.O. Box 550, Truro, B2N 5E3	895-1571	B2N 5E3	
Cumberland	Experimental Farm, Nappan, B0L 1C0	667-8722	Provincial Soil and Crop Specialists	895-1571
Iverness	P.O. Box 70, Mabou, B0E 1X0	945-2999	Forages, Corn & Grain Spec.	895-1571
		945-2340	P.O. Box 550, Truro	
Halifax	Middle Musquodoboit, P.O. Box 97, B0N 1X0	384-2262	B2N 5E3	
Pictou	P.O. Box 160, Pictou, B0K 1H0	485-4317	Regional Soil and Crop Specialist	678-7365
Annapolis	Lawrencetown B0S 1M0	584-2231	Research Station	
Digby	P.O. Box 309, Weymouth, B0W 3T0	837-5161	Kentville	
		837-5162	B4N 1J5	
Hants	P.O. Box 248, Windsor, B0N 2T0	798-8377		
		798-8378		
Kings	Research Station, Kentville, B4N 1J5	678-7365		
Lunenburg	99 High Street, Bridgewater, B4V 1V8	543-9191		
Yarmouth	10 Starr's Road, Yarmouth, B5A 2T1	742-4334		



